ILLUMINATING ENGINEERING

JULY 1954

Graphical Determination of Room Indexes
Ulbricht Sphere for Large Luminaires
Characteristics of Mercury in Lamps
Applications of Lighting Principles
Lighting the Small Amateur Stage
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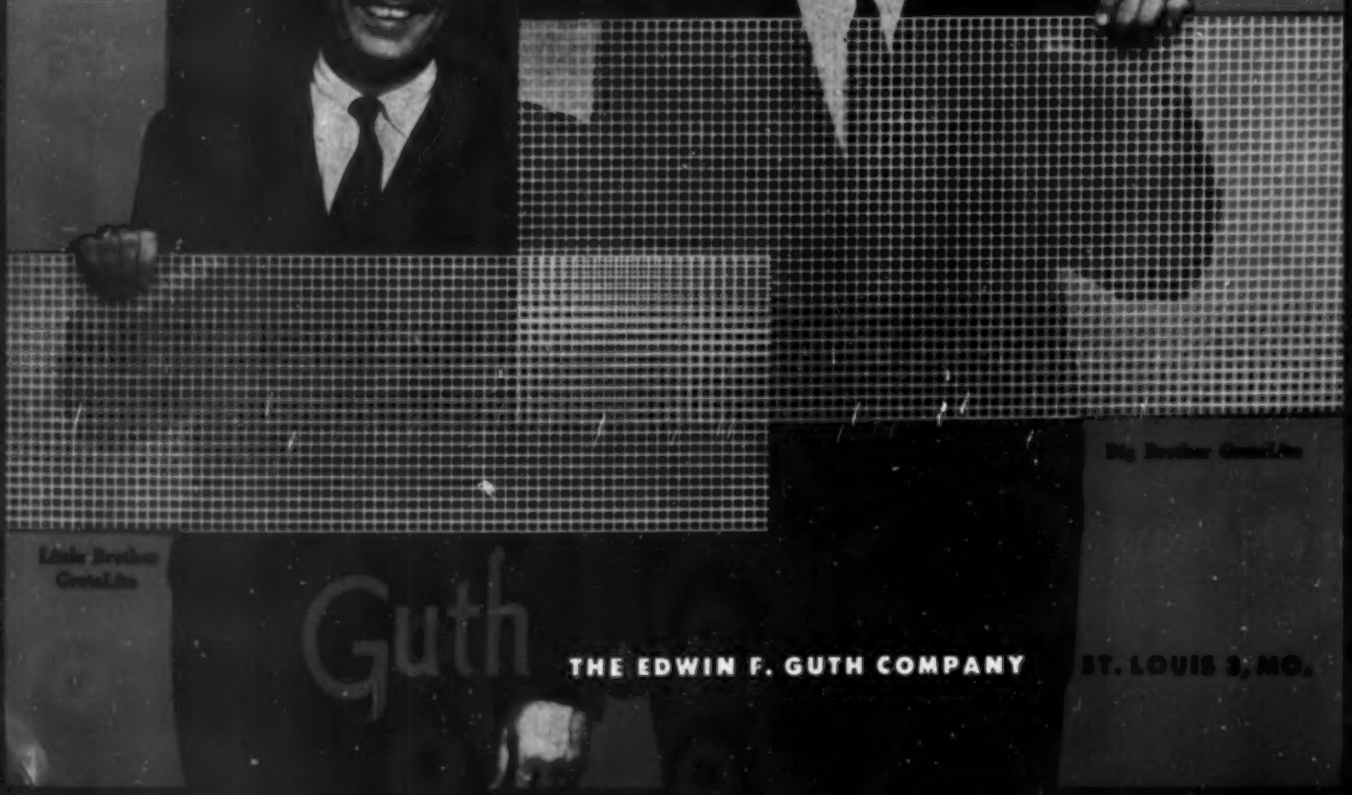

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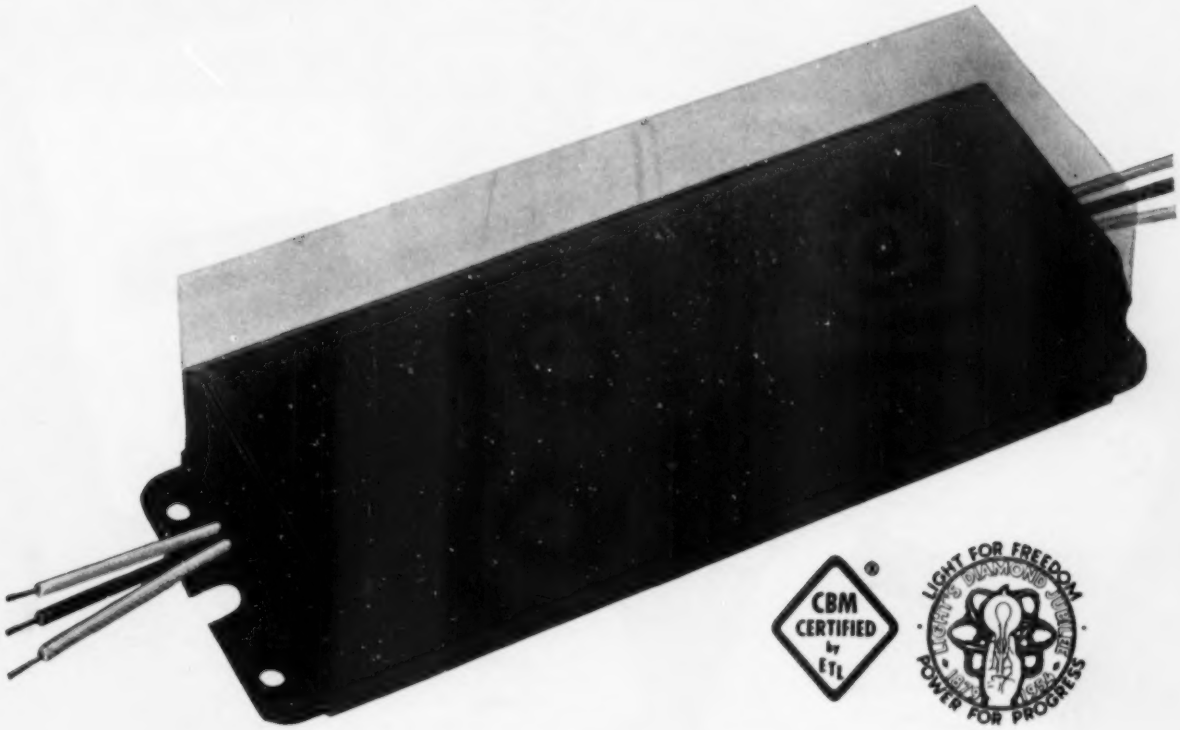

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THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

JULY
1954

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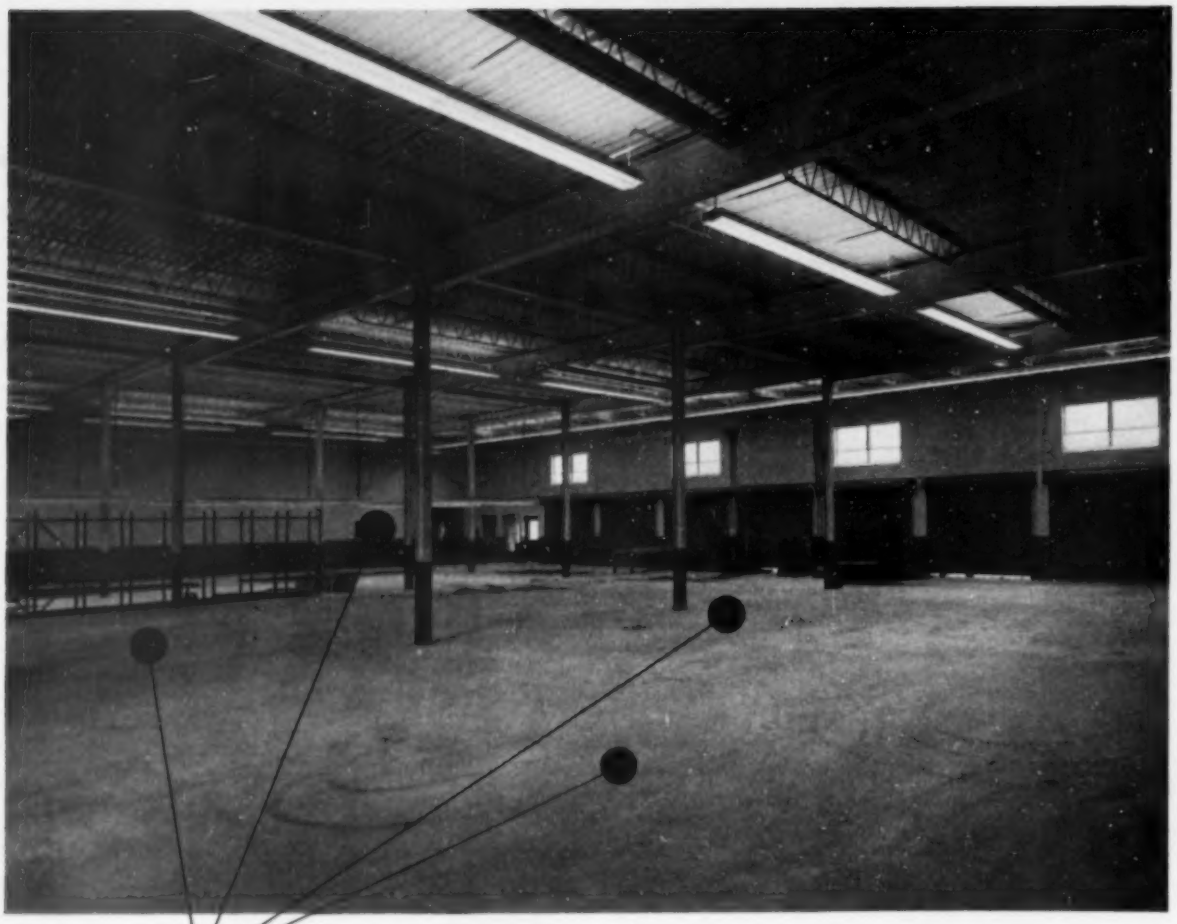
PUBLICATION office 32d Street & Elm Avenue, Baltimore 11, Md.
EDITORIAL and advertising offices 1860 Broadway, New York 23, N. Y.

ILLUMINATING ENGINEERING: The Journal of the Illuminating Engineering Society. Copyright 1954 by the Illuminating Engineering Society. Published monthly in the United States of America. Entered as second-class matter at the Post Office, Baltimore, Md. Acceptance for mailing at special postage rates provided for in Section 1103 P.L.&R., Act of October 3, 1917. Authorized July 16, 1918. ¶ Subscription $12 per year plus extra postage to all countries to which second-class postage rates do not apply; single copies $1.00. ¶ Address changes must be received at I.E.S. headquarters by the first of the month to be effective with the issue of the next succeeding month.



four areas here are custom lighted by **Litecontrol**

Variations in height and spacing of a single LITECONTROL fixture give each of the four working areas on this warehouse floor just the right light for its needs. Intensity is low in the heavy storage area (foreground), higher over the accessories racks (background). Other work areas, each custom lighted, are the assembly line (near the rear wall) and the loading area (by the doors).

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INSTALLATION: Sun Oil Company, Dayton, Ohio

AREA: Warehouse

PROJECT ENGINEER: Alex M. Engart, Engineering Dept., Marketing Division, Sun Oil Company

ELEC. CONTRACTOR: Heildoerfer-Castellini, Dayton, Ohio

FIXTURES: Litecontrol No. 2428 2-lamp slimline industrial

MOUNTING HEIGHT: 17'-6" and 9'-0"

INTENSITIES: Over storage racks (foreground), 15 Footcandles in service — Accessories racks (low fixtures, background), 35 Footcandles in service — Motor Oil Assembly lines (background), 25 Footcandles in service — Loading area (near doors) 15-20 Footcandles in service

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Views and Opinions

The Dollar Value of Light

THE QUESTION "What is the dollar value of artificial light?" can be answered in a broad way by asking what would happen if we could turn the clock back and take away artificial light, restrict the working day to the periods when sufficient natural light is available and restrict working spaces and facilities to those to which sufficient daylight is accessible?

WE would be back to man-hour rates of 1880's — before the introduction of cheap artificial light freed us from the strait-jacket of natural lighting. And our national income would be comparably low. The population would drop also, as the means to support our present numbers couldn't be maintained under such conditions.

EARLY civilizations were all summer economies. When the winter closed in there was little they could do except prepare for spring. The Romans were the first people to develop an all-year economy that was relatively independent of the weather. They did this by inventing the chimney which permitted them to have year round control of their indoor climate, because they could build weather-proof heated buildings in which they could continue to work through the winter and continue to carry on year-round manufacturing and trading at fair efficiency. Their discovery of indoor climatic-control disappeared with their eclipse from the world scene and after the collapse of the Roman Empire, Europe returned to the stagnant status of a summer economy.

WITH the discovery of coal in the twelfth century and the need for a flue to take off its noxious smoke and gases, the chimney was re-invented or re-discovered and again in Italy, the first modern chimney being erected in Florence according to the English historian, Markham. From there it spread all over Europe in about one hundred years even to Lapland. Thus began the great surge forward of the Western world, that has been developing ever since. Europe as a whole went on an all-year economy as a result of the development of indoor climatic controls which permitted continuous indoor work, independent of the weather.

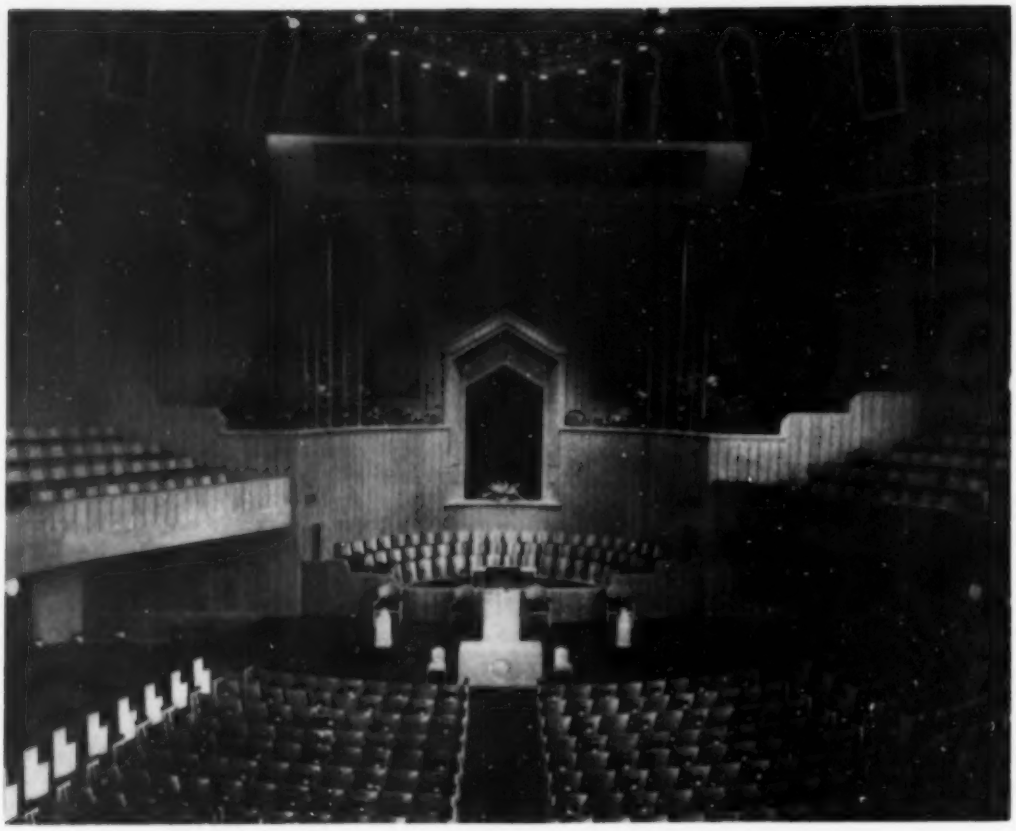
THE NEXT great step was the development of cheap artificial light in the 1890's which made a round-the-clock, twenty-four-hour economy possible. Our national progress stems from then. In 1890 our population was 75,000,000 and our national income $14,000,000,000. The two curves of population increase and national income rose at the same rate each decade from the first census in 1790. During that century we were an agricultural, year-round daylight economy.

SIXTY years later our population had doubled but our national income had increased 1400 per cent, because the adoption of controllable, dependable, cheap artificial light had made it possible to operate our transport, our communications, our services and our production without letup, continuously 24 hours of the day. It permitted the development of large concentrated working spaces that were impractical as long as workers had to depend upon daylight, which will not permit satisfactory operation more than about 20 feet from windows. Today, even if optical contact through wall glazing is available in factories, the factories are at all times operated by artificial light and could not be operated any other way. So are most office spaces.

OUR present American civilization rose on artificial light and it is still the only civilization in the world that has exploited artificial light to a great degree. That is one of the reasons why the value of the output of the five per cent of the world's people that live in the United States is 45 per cent of the world's output. If cheap artificial light had not come along we have no reason to believe our national income today would be increasing any faster than it was in 1890 or 1880 or 1870, back to 1790 when the rate of increase was proportional to population increase. On that basis our national income would be about $28,000,000,000. It is at least ten times that and the difference is the dollar value of light to the American people.

THE DEGREE to which our particular civilization is dependent upon artificial light is fantastic to the unobservant. It penetrates every nook and cranny of modern living, from the delivery room where the new life comes into the world, the nursery where it spends its first few days, the ambulance that takes it home, the home in which it grows, the school in which it is taught, the roads it has to travel at night, the office, the institution or factory it works in, to the mortuary where it is finally laid out. This omnipresent artificial light determines our entertainment and shapes our customs. Its influence is everywhere in this country and this country is the light of the world.

H. L. Logan
Vice-President in Charge of Research
The Holophane Company, New York



Church Relighting—A Prize Problem

By GORDON WELLS

RELIGHTING churches is frequently the lighting man's most challenging job, and as a consequence his most interesting. Some of its problems can be solved "by the book." Nine times out of ten, however, he has to search his imagination, seek inspiration, and come up with something brand new. And ten times out of ten it must be done on a restricted budget.

Relighting the First Baptist Church in Asheville, North Carolina had its quota of problems. No plans of the building were available. The structure featured a dome 90 feet above the floor, and a nave 90 feet in diameter. There was no room to recess lighting equipment in the sides of the dome. The church committee was dead set against hanging lanterns over the balcony area.

Whether before or after remodeling, most aspects of a church structure must remain fixed. Difficult dimensions may rarely be altered. In this church the structure was an octagon, each of the eight sides being 40 feet, with a parabolic dome for roof, 90 feet high at its peak, in shape similar to a coffee cup upside down. At the apex of the roof was another dome 16 feet in diameter, an air vent originally designed to ventilate the church.

The balcony area extended in tiers on seven sides of the octagon all the way round. On the eighth side is the Baptistry, choir and pulpit. Ornamental windows extend all round, at the first slope of the domed ceiling.

Existing lighting was from a cove 47 feet above the floor, using 200-watt lamps on approximately

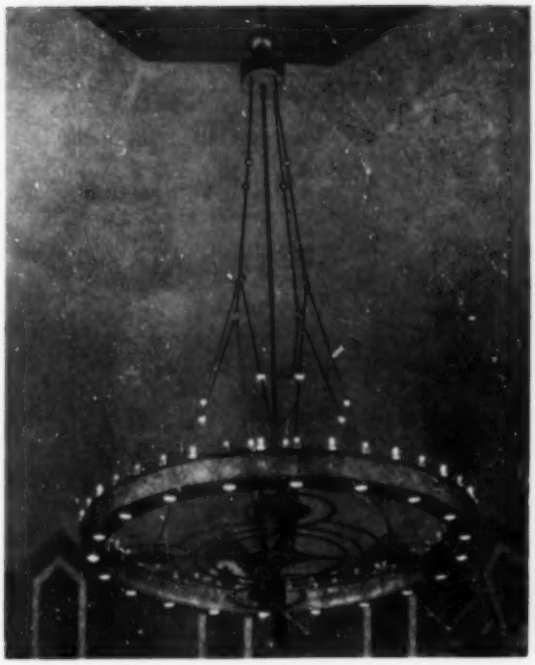
This installation won first prize in the Carolinas Section, and placed second in the Southern Regional contest. Other winning installations will appear in the forthcoming issues of ILLUMINATING ENGINEERING. AUTHOR: The Gordon Wells Company, Charlotte, North Carolina, representative for Rambusch Decorating Co.

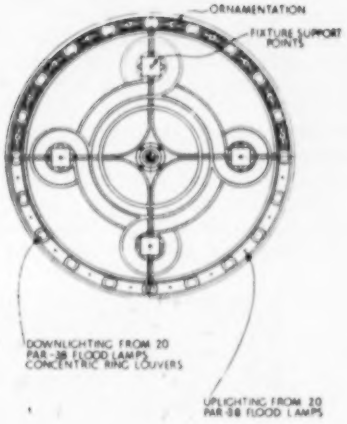
18-inch centers. Light from these sources was reflected from a gray acoustical plaster. On the floor level the illumination did not even register on a footcandle meter, so low was its value.

Solution

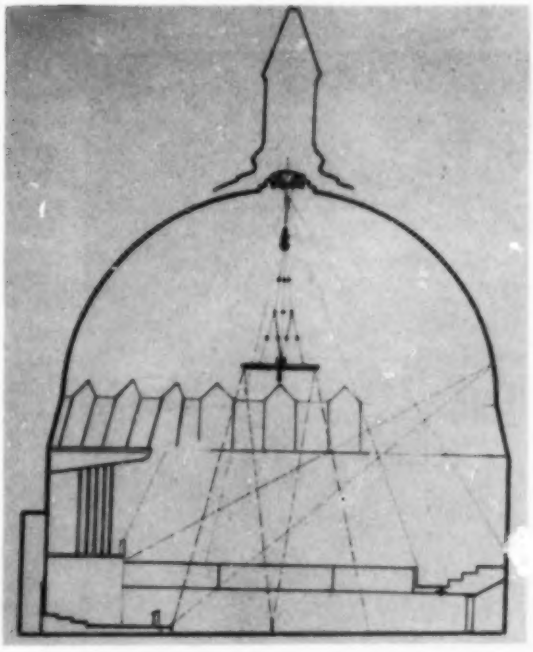
To illuminate the nave we designed a gigantic chandelier, to be suspended from the peak of the dome, which would of course be the precise center of the octagonal area. The chandelier is 15 feet in diameter, and 35 feet overall in height. Suspended from the top of the dome, it is 45 feet above the floor. Incorporated into the ornamental design of the unit are 20 PAR-38 floodlamps beamed downward for direct illumination, and 20 beamed upward to reduce brightness contrast. Six circuits in the center stem service these sources. Relamping is accomplished by the use of a winch installed in the air vent. For an idea of the scale of this chandelier, the supporting rods are one inch in diameter, and the tassel at the bottom is two feet long.

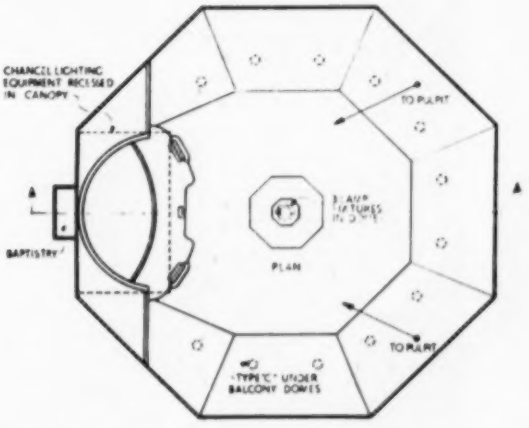
For illumination of the balcony and choir, space in the outer area of the air vent in the top of the dome was used for the installation of seven clusters of 300-watt PAR lamps, three lamps to each cluster. These lamps are in adjustable housings so they




ORNAMENTATION
FIXTURE SUPPORT POINTS
DOWNLIGHTING FROM 20 PAR-38 FLOOD LAMPS CONCENTRIC RING LOUVERS
UPLIGHTING FROM 20 PAR-38 FLOOD LAMPS

Solution to the problem centered around the design of the mammoth chandelier, 35 feet in height and 15 feet in diameter, shown at upper right. As noted on the plan view of the unit, at right, its effective lighting feature is from shielded downlighting, plus uplighting to reduce brightness contrasts. The complete lighting plan is shown in the two drawings below.





may be rotated for adjustment on the job. Why seven units, with one blank section? While we were working on the lighting, the acoustical engineers decided that a canopy was required over the choir and pulpit in order to cut down echoes.

This canopy, however, gave us another means to an attractive lighting effect, in addition to its architectural beauty and acoustical function. Growing plants on each side and under the canopy, above the choir, were part of the decorative scheme. In the ceiling of the canopy we installed six 250-watt mercury vapor units with rectangular apertures, so arranged to cover only the plants. The units were tilted to prevent any of the mercury color from striking the choir proper. The mercury vapor sources dramatize the greenery for a very beautiful effect, in keeping with the serenity and spiritual atmosphere of the interior.

For functional illumination of the choir, six 500-watt downlights are recessed in the canopy, and for strategic spotlighting eight 150-watt PAR-38 spots. For further highlighting, when required, two 300-watt narrow beam spotlights located at the back of the church may be beamed on the pulpit.

At full intensity, illumination is 10 footcandles in the nave and 32 footcandles on the pulpit and choir. There are separate dimmers on the dome and chandelier, pulpit and choir. and a master dimmer to control all of them. Thus any desired level or lighting effect may be obtained.

The installation was a most satisfying one to complete, as well as interesting. We have utilized an old idea, in the chandelier, but have incorporated modern sources, and overcome obstacles which seemed almost impossible. The result is quite effective — functionally and esthetically; the chandelier seems to float in space. The total absence of apparent light sources in the canopy and the general overall appearance blend well together.

The most satisfying result, however, was enabling others to *see*, which is our prime function in this business.

New Type Cold Cathode Source Lights Restaurant Marquee

The marquee of the Mayan Room at Restaurant Mayan, Rockefeller Center, New York, was recently renovated to use a new type of cold cathode lamp. Two rows of 35 mm 240 ma cold cathode lamps, a recent development in cold cathode fluorescent sources, were installed on baked white enamel reflector pans attached to the interior ceiling of the marquee. The bottom of the marquee is finished with Albalite glass panels installed below the lamps and flush with the bottom edge of the marquee. Two additional lines of 35 mm cold cathode lamps are used to light the letters of the perimeter face of the marquee. The new 35 mm cold cathode lamps are approximately 8 feet long, and are made in the form of a hairpin with the sides 6 inches on center. They are 1.5 inches (T12) in diameter. The installation at Rockefeller Center produces 38 footcandles at sidewalk level. Carson and Lundin of Rockefeller Center, were the architects for the job and Dooley Electric, also of New York, installed the equipment. Photo and data courtesy of Cold Cathode Lighting Corp., Long Island City, N. Y.

Characteristics of Mercury in Lamps

By L. J. BUTTOLPH

Another in the series of articles on the characteristics of materials used in the lighting industry. One of the earliest-known elements, mercury has some unique properties and several different uses.

MERCURY, either directly or disguised in fluorescent lamps, now produces more artificial light in the United States than does tungsten, even though twice as much electrical energy may still be used to heat tungsten lamps. These new uses of one of the oldest known elements suggest a review of its history and properties, and some comparisons with tungsten.

Hydrargyrum (Hg)

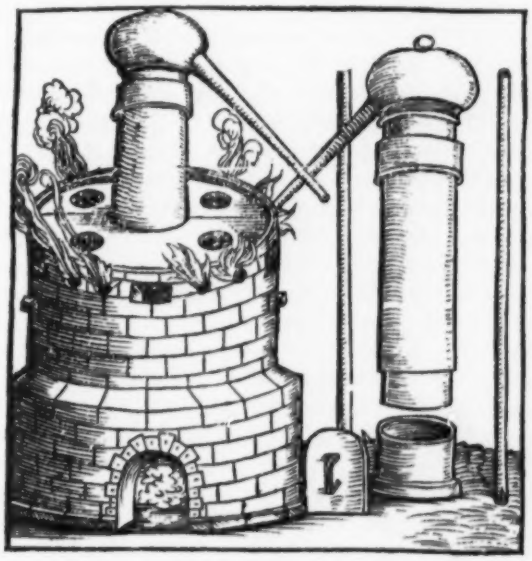
Mercury originally had the impressive name of hydrargyrum, Latin from descriptive Greek words, meaning silver-water and very suggestive of today's common name of quick-silver. It was later appropriately named mercury from the versatile, mythologic, Greek Messenger of the Gods, and Roman God of Commerce, and shares the name with our smallest planet and the one nearest the sun. Aside from the name, that planet is of interest to illuminating engineers because the side (about one-third its surface) nearest the sun is perpetually illuminated to a level of the order of 50,000 footcandles, about the surface brightness of a 1000-watt mercury lamp, color improved by a phosphor lining. With that light is relatively much more ultraviolet and infrared than reaches the earth and so the planet's surface temperature is estimated as about 240°F. The perpetually unilluminated opposite side is estimated to be at about the absolute zero of −460°F. Mercury lamps would not operate there for reasons which will appear later. Those who prefer a changeable climate could find it in the intermediate zone where there is a 700°F change in temperature every 88 days.

Known to the Ancients and Alchemists

Aside from the mythologic associations of the name, the metal mercury has a romantic history. Like tin, lead, antimony, gold, and copper, mercury is sometimes found free from other elements, and so was among the earliest metals known and used by man, perhaps as early as 1954 B.C.! It is also known to have been recovered from its sulfide, cinnabar, by treatment with vinegar and copper, as early as 300 B.C.

Being a liquid the metal had no such practical uses as solids like soft lead, gold and bronze have, but its common ore, cinnabar, of a dark scarlet or vermillion color was prehistoric in use as a paint. It has only recently been superseded to any extent by other red pigments.

Because of its unique characteristics for a metal, the striking color of its cinnabar ore, the ease with which it combined chemically with other elements and physically with other metals, as amalgams, mercury was of the greatest of interest to alchemists. They attributed to it all sorts of physical, chemical, and therapeutic properties. In spectacular effects on patients it was exceeded only by antimony whose name is reputed to have described its lethal effect on monks. Fantastic and varied as they were, none of the dreams of the ancients or the alchemists seem to have anticipated in any way the relatively recent use of electrically excited mercury to replace their flame sources.



Known to the Ancients and alchemists.

AUTHOR: Application Engineering Dept., Lamp Division, General Electric Co., Cleveland, Ohio.

Occurrence

Mercury sulfide or cinnabar occurs in nearly all geological formations and in close association with other ores in nearly all parts of the world. A variety of factors such as accessibility, labor, tariffs, and transportation have influenced the changing locations of the most important mercury mines. Somewhat in chronologic order, the more important mines have been located in Spain, Italy, Mexico, Peru, and in California, Texas and Idaho of the United States. Much of the mercury now used in the United States apparently comes from Idaho.

Metallurgy

At the mines, metallic mercury is obtained from cinnabar by a combination of roasting with excess air, and distillation. Sulphur dioxide is formed and mercury condenses in extensive cooler parts of the furnaces. Filtration through chamois skin provides a remarkably clean looking product. Additional distillation may be required to remove such dissolved metals as zinc, arsenic, antimony, tin, silver, and gold. Known as virgin mercury, in contrast with that recovered from other mining and industrial uses, such mercury, direct from the mines, is of remarkable purity (99.9999 per cent relative to base metals) compared with almost all other commercial grade metals. This purity is entirely adequate and even superfluous for many of the industrial uses of mercury, including that in the mercury vacuum pumps extensively used in the evacuation of tungsten and mercury lamps.

Use — Cost

The total national use of mercury was about 1,000,000 pounds in 1953, of which the lamp industry used about 50,000 pounds or 5 per cent. Of this total perhaps only about two per cent or 1000 pounds actually went into finished mercury and fluorescent lamps. It would be interesting to know how this compares with the amount annually used in the manufacture of mercury thermometers. It is but a small fraction of the amount once put into the mercury pool cathodes of Cooper-Hewitt lamps, each of which took three to six ounces or enough to make 4000 40-watt fluorescent lamps.

During the time of its use in lamps mercury has varied in price from one to three dollars per pound. This represents a cumulative quantity and cost variation of 20 cents to $1.10 per Cooper-Hewitt lamp but only about one to six-hundredths of a cent per 40-watt fluorescent lamp. In fluorescent lamps the cost of the metallic mercury used is insignificant compared, for example, with the cost of putting it into the lamp. The largest, 1000-watt, industrial lighting mercury lamp, contains little more than one-tenth cent of mercury at the current cost of about $2.75 per pound. A 2-oz. jigger of mercury would weigh about 1½ pounds and cost about $4.00. There are other good reasons for not drinking the liquid.

Purification

For the conducting vapor in mercury and fluorescent lamps, a tenfold greater purity (one part foreign metal to ten million parts mercury) is secured, by washing with dilute nitric acid to remove traces of metals more active than mercury. There follows distilled water washing and drying, and thereafter a slow vacuum-distillation at low temperatures to minimize the carry-over of traces of such amalgamated metals as silver, platinum, and gold.

One of the useful and unique peculiarities of mercury, somewhat inherent in its normally liquid condition, is the way in which its physical appearance indicates its purity. Contamination by common metals, other than gold and silver, much less than can be detected by sensitive chemical or spectrographic methods, produces visible signs. The signs are a dull appearance of the mercury surface after it has been stored exposed to air, sometimes accompanied by a ring of color at the line of surface contact with a clean glass container after a day or two of storage. Another sensitive indication of purity is the extent to which a droplet of mercury on a very clean glass surface tends to ride high on the glass and retain its oblate spheroidal shape during slight movement. Very slight contamination will cause the droplet to "drag a tail" and additional contamination increases the flattening or oblateness of form and the tendency to distortion upon movement through all intermediate stages to that of a complete wetting of the glass and a spreading out into a thin film of mercury. Advantage was taken of an extreme case of this in the manufacture of mirrors coated with a mercury-tin amalgam, since almost entirely replaced by silver.

Physical Properties

Mercury and tungsten have contrasting physical properties. In Table I sodium is also shown as the one other metal vaporizing at low enough temperatures for use in electric discharge lamps. Among the common metals, mercury has the lowest melting point, −38°F (and so is normally a liquid but becomes a brittle solid when "frozen" with liquid air) and tungsten the highest, 6100°F. Mercury has the lowest boiling point, 675°F (and is often above that temperature in the higher pressure

A slow vacuum distillation at low temperature follows washing with dilute nitric acid and distilled water washing and drying in process of purification.

lamps) while tungsten has the highest boiling point of all metals, 8540°F (and so cannot be boiled in any metal container). In lamp use, the paradoxical aims are maximum vaporization of mercury at minimum temperatures, and minimum vaporization of tungsten at maximum temperatures.

TABLE I.—Physical Properties

	Mercury	Sodium	Tungsten
Density	13.55	0.97	19.
Atomic Weight	200.	23.	184.
Melting Point	−38°F	207°F	6098°F
Boiling Point	675°F	1616°F	8540°F
Cost per lb.	$3.	20c	$5.

"A comprehensive Treatise on Inorganic and Theoretical Chemistry," by J. W. Mellor, Vol. 4, p. 695, contains 354 pages on mercury.

Isotope — 180

Mercury qualifies as modern by having several stable isotopes. The one with an atomic weight of 180 is used in very special, small mercury lamps for laboratory use. It provides a more sharply defined green 5461Å wavelength of value in spectroscopy and interferometry. Such lamps are available from the National Bureau of Standards.

Mercury in Lamps

Mercury has been used in two separate and independent ways in discharge lamps, as a liquid carrier of a self-maintaining "cathode spot" and as a vapor conductor of electricity. A "cathode-spot" on a mercury surface is a remarkably simple and flexible electronic device capable of almost indefinite expansion of its current capacity. Mercury vapor is a comparably adaptable carrier of electricity. With little change in voltage drop and in apparent defiance of Herr Ohm, a small tube of mercury vapor will carry almost any current from one-hundredth of an ampere to one-hundred amperes, until the tube melts.

Mercury Metal as Cathode

Once formed, a mercury "cathode-spot" will pass from one to 100 amperes with little change in its voltage drop of about 5 to 7 volts. The energy represented by the product of the current and this voltage drop serves to eject electrons and mercury vapor in a volcanic-like blast from a crater-like depression in the mercury surface, formed largely as a reaction to the ejected electrons and mercury vapor. Some of the energy, as heat, is also conducted away by the liquid mercury surrounding the cathode crater. Inherent in the operation of the mercury cathode is the fact that it requires at least one ampere or 5 to 6 watts, supplied continuously. Even at much higher currents a mercury cathode will extinguish on current interruptions of one-thousandth of a second or longer. This means that a mercury cathode, or two such cathodes, cannot be used in discharge lamps on low-voltage alternating currents of less than about 1000 cycles per second. For this reason the mercury cathode is inherently a direct current device. The earliest mercury lamps were operated in such a way as to provide a pulsating direct current from a single cathode, alternately to two anodes. This was the famous Cooper-Hewitt full wave rectifying principle still fundamental in nearly all radio circuits and still used in the large rectifiers providing direct current for electrochemical processes. The only modern mercury cathode lamps are operated

at extremely high temperature and pressures, in one-sixteenth by one-inch fused-quartz-glass tubes, water and air-cooled for an input of 1000 watts.

Mercury Vapor as a Conductor

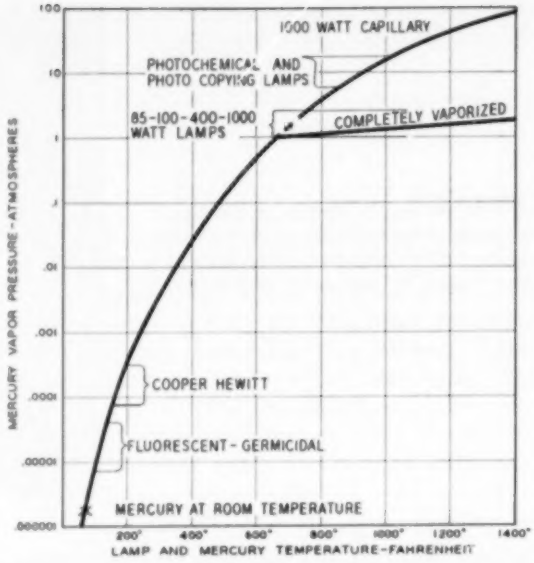
In a tube of mercury vapor, and mercury has a vapor pressure of one millionth atmosphere even at room temperatures, containing electrodes connected to a source of power very little general ionization will start a chain reaction. Any current at all produces more ionization, by collision the physicist says, and so more current flows. In such a conducting condition the only limit to the current carrying capacity of the mercury vapor is the heating of the tube containing the vapor. That limit is reached in the above water and air-cooled quartz-glass tubes whose inner surfaces are practically molten.

All electric discharge lamps have such an unstable relationship between their current and the voltage supplied to them that their current can only be controlled by adding impedance (resistance or reactance) in series. In practice about one-half the voltage from a supply line or from a transformer is absorbed by the series ballasting device. In mercury vapor lamps the light produced is only very indirectly related to the lamp current and temperature and that relationship is usually the opposite of what is expected.

Mercury as a Light Producer

A comparison with tungsten may help to an understanding of mercury as a light producer. When sufficiently heated the atoms of tungsten are thought of as vibrating at such high frequencies as to radiate energy of corresponding various wavelengths to which our eyes are sensitive. We call the energy, and also the sensation it produces in the eye, light. Mercury vapor is seldom heated to a high enough temperature to emit light in that way, except perhaps in the above 1000-watt high pressure lamp. Even there it is an incidental effect.

When electricity passes through mercury vapor, the mercury atoms absorb some of the energy and become excited or activated independently of any heating effect. Their complicated internal structures, sometimes described as miniature solar systems, are momentarily very disturbed, but of course not to the extent of fission. That takes much higher speed electrons than are generated in mercury arcs. (Mercury arcs with their electron speeds greatly increased by magnetic fields were studied for traces of gold, first degeneration product of mercury, 30 years ago, but the magnetic fields of that day were not strong enough.) The excited mercury atoms



Vapor pressure is that of liquid mercury at the temperature of the coolest part of the lamp tube, until all the mercury is evaporated. Beyond that critical point the vapor pressure increases strictly proportionately to the absolute temperature.

return to their normal condition by emitting or radiating the energy that previously excited them. Thus hot tungsten emits light from its vibrating atoms while relatively cool mercury emits light from the similar movements of electrons entirely inside its atoms. The remarkable thing is that the emitted energy bears little or no resemblance to the previously absorbed electrical energy. Instead of containing the full range of frequencies or wavelengths characteristic of the light from hot tungsten it contains only a relatively few wavelengths which produce corresponding sensations of color in the eye. These wavelengths and their relative intensities tell the physicist a detailed story of the internal structure of the mercury atoms. In this respect the radiation from every excited metal or gas differs from that of every other.

In this connection it is interesting to note that the various wavelengths sorted out of the electrical energy by excited mercury vapor are, in effect, recombined in the eye. Each wavelength seen as a line in a spectroscope excited one or more of the primary color sensations in the eye, as if it were of a wide range of wavelengths. This is analogous to the way in which just a single line in the ultraviolet (2537Å) will produce a broad range of wavelengths of light from such phosphors as are used in fluorescent lamps. The coincidental wavelengths and intensities of the mercury lines are such as to

produce in the eyes a white light sensation similar not only to that from hot tungsten, but blue-white as from molten tungsten. Why such an apparently white light does not satisfactorily render colored objects and how it may be improved is somewhat beyond the scope of this article.

Of all the vapors or gases that might be used in a discharge lamp, mercury vapor is unique in nearly every way and so almost non-comparable with any other except by the differences, sodium being the only one at all comparable. The fixed pattern of wavelengths which mercury vapor emits when electrically excited can be changed only to the extent of, but fortunately to the considerable extent of, changes in the relative intensity of the various wavelengths, or spectral lines as they are called from their appearance in that light-sorting device called a spectroscope. And this leads us to the practical fact that in modern discharge lamps mercury plays two roles, one as a direct producer of light in higher temperature and pressure lamps, the other in disguise as an indirect producer of light through its ultraviolet and fluorescent phosphors.

Temperature and Vapor Pressure

An oversimplified story of the discharge lamp can be based on its vapor pressure, just as the story of the incandescent lamp can be based on the temperature of a tungsten filament. In a sealed lamp tube of any given length and diameter the electrical and the light emitting characteristics depend upon the mercury vapor pressure. Temperature produces this vapor pressure but it is only the temperature of the lamp bulb or tube and is expressed in hundreds instead of thousands of degrees. From a start at room temperature, the heating by the electric discharge produces a vapor pressure which is that of liquid mercury at the temperature of the coolest part of the lamp tube, until all the mercury is evaporated. Beyond that critical point the vapor pressure increases strictly proportionately to the absolute or Kelvin temperature (Centigrade plus 273°C). The voltage required to maintain any given current through the lamp follows the change in vapor pressure closely. Pressure limitation by complete vaporization is practiced only in lamps operating at about one atmosphere pressure.

The relationship between temperature, the vapor pressure, and the gas-law pressure may be expressed in Fahrenheit degrees and atmospheres. By definition, the boiling point of mercury is that temperature (675°F) at which its vapor pressure is the same as that of the atmosphere in contact with it. In a mercury discharge lamp the internal pressure is therefore the same as the external at a lamp and mercury temperature of 675°F (357°C).

Older mercury lamps of the Cooper-Hewitt type had large pools of liquid mercury and so always operated in the vapor pressure phase. For that reason they were very sensitive to slight changes in the temperature of their tubes, especially the cathode end which held the mercury pool. Modern discharge lamps operate in the gas-law phase with the mercury fully vaporized, and so are relatively insensitive to external temperatures in spite of their own higher temperatures. To further increase this temperature stability they are enclosed in outer tubes or bulbs.

Vapor Pressure and Radiation

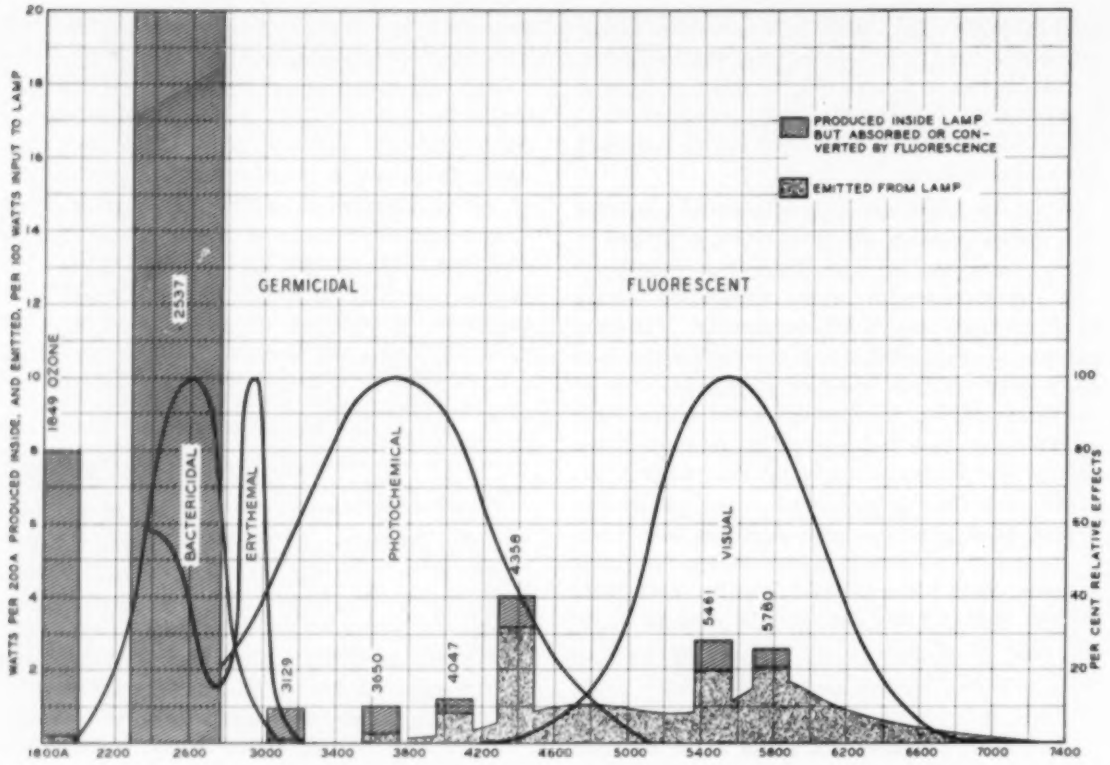
The effect of vapor pressure on the energy content of the many visible and ultraviolet lines emitted by excited mercury vapor is far more complicated than the effect on the electrical characteristics. These variations will be represented by the four typical conditions, which have existed in commercial lamps, the very low pressure operation of germicidal and fluorescent lamps, the low condition in the historic Cooper Hewitt lamp, the relatively high pressure condition in modern limited pressure mercury lamps, and the very high pressure condition in 1000-watt water and air jet-cooled capillary lamps.

The first (1643) observation of a "mercury discharge light" was on the surface of the mercury in the Torricellian vacuum (one millionth atmosphere) of a barometer column.

Very Low Temperature and Pressure — 100° - 140°F — One Hundred Thousandth Atmosphere

The most efficient conversion of electricity into radiant energy occurs at relatively very low temperatures and pressures. Inside such lamps about 60 per cent of the electrical input to the lamp is converted to wavelengths 2537Å and 1849Å, with a remaining four per cent in other ultraviolet lines and two per cent in visible lines. In lamps for germicidal uses about two-thirds of the 2537Å, but little of the 1849Å energy, or about 35 per cent of the total input is transmitted by the lamp tube. The two per cent in visible lines provides an overall luminous efficiency for such a lamp of only 4 to 5 lumens per watt.

Very low vapor density, pressure and temperature, and relatively low intensity (amount per inch of lamp length or square inch of lamp surface) ultraviolet from germicidal lamps and light

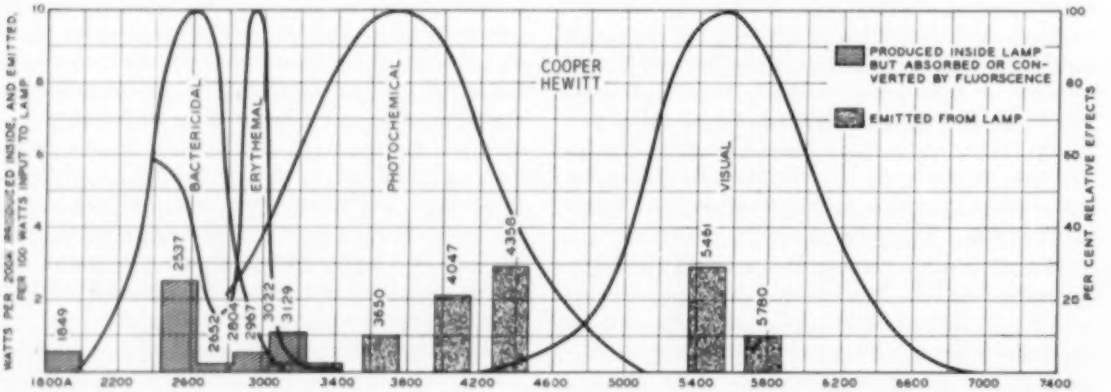


The most efficient conversion of electricity into radiant energy occurs at relatively low temperatures and pressures.

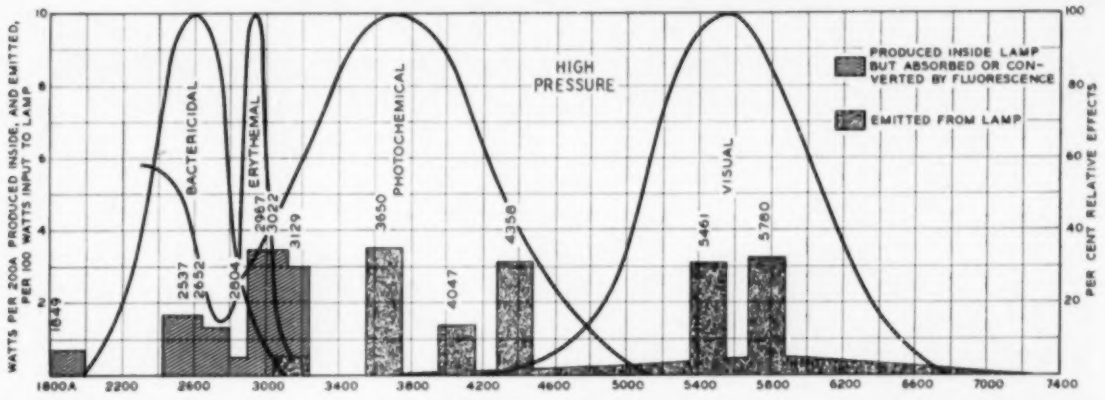
from fluorescent lamps is an inherent characteristic of such lamps. In the search for the best conditions for 2537Å production a lamp surface temperature range of 100° to 140°F has been well established. Any departure from this condition by changes in power input or by external heating or cooling reduces efficiency greatly. Efficiency and very high output intensity are incompatible in such lamps.

Fluorescent Lamps

Phosphors on the inner surface of such a lamp tube can convert the 1849Å and 2537Å ultraviolet into visible energy of a spectral distribution providing luminous efficiencies of 55-75 lumens per watt, depending upon lamp sizes and light color. Such phosphors processed and applied to the inner surface of fluorescent lamps transmit about 25 per



At low temperatures and pressures the unique 1849A and 2537A wavelengths are no longer effectively produced but equivalent energy appears in other ultraviolet lines.



With increased lamp temperature and vapor pressures there is a further shift of emitted energy from the ultraviolet to visible wavelengths.

cent of the visible wavelengths accompanying the activated ultraviolet. Although they contain but little visible energy and are only partially transmitted they greatly complicate the problem of duplicating exactly the color rendering and the photographic qualities of either daylight or incandescent light. In effect, they superpose on all fluorescent lamps some of the spectral characteristics of the Cooper-Hewitt lamp.

Since fluorescent lamps are inherently sensitive to temperature and air movement it is sometimes suggested that they be operated with the mercury totally vaporized. Desirable as that might be it has not seemed practical. The microscopic amount of mercury represented by that in even the largest fluorescent lamp is so small that the slightest oxidation or other chemical action in an operating lamp could seriously change the delicate balance of factors essential to the most efficient production of 2537Å energy.

Low Temperature and Pressure — 175° - 200°F — One Ten-Thousandth Atmosphere

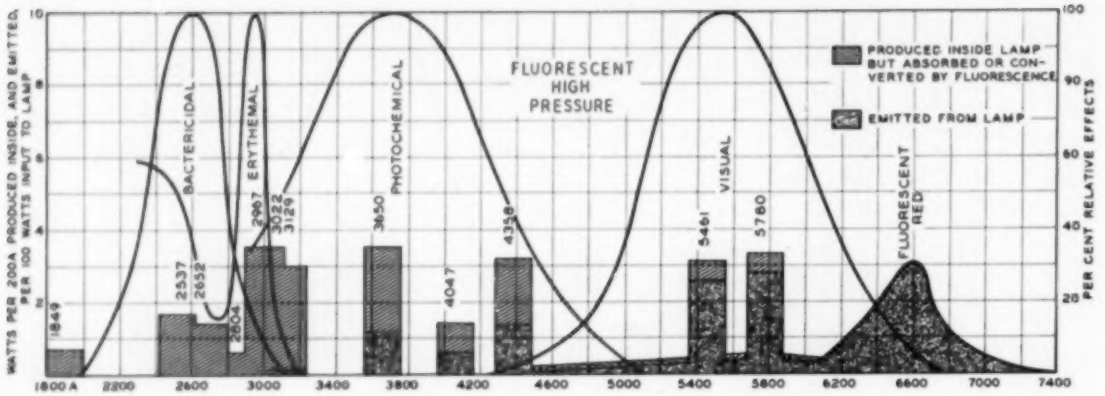
At low temperatures and pressures the unique 1849Å and 2537Å wavelengths are no longer effectively produced but equivalent energy appears in other ultraviolet lines and the increase in the relative intensity of the visible 4047, 4358, 5461 and 5780Å lines is marked. Such lamps, represented by the Cooper-Hewitt types, have a luminous efficiency of about 25 lumens per watt in the lamp. This efficiency and the low brightness of the 4-foot long source made the Cooper-Hewitt lamp useful to industrial illumination in spite of its cumbersome operating equipment and color distortion by its light. The high output of blue, violet and ultraviolet also made the lamp useful in commercial photography and photocopying applications not involving color rendition. In 1940 the greater efficiency, better color rendition, lower surface brightness, and simpler operation of low pressure fluorescent mercury lamps rapidly made the Cooper-Hewitt lamp obsolete. While the Cooper-Hewitt lamp operated at a relatively low temperature and pressure its current density was ten times that of fluorescent lamps of comparable diameter and this made its radiation characteristics resemble those of high pressure lamps rather than low.

High Temperature and Pressure — 600° - 800°F and 1 - 3 Atmospheres

With increased lamp temperatures and mercury vapor pressures there is a further shift of emitted energy from the ultraviolet to visible wavelengths, just the opposite of the effect of temperature on a tungsten filament. The result is luminous efficiencies of 45-50 lumens per watt into the lamp.

Commercial types of high pressure mercury lamps are operated as so-called limited-pressure devices. This is because all their mercury is evaporated and the vapor pressure changes relatively slowly with changes in electrical input resulting from changes in the electrical supply. They become relatively constant voltage devices. The introduction of accurately measured amounts of mercury in minute and barely visible doses presents one of the more difficult problems in the manufacture of such lamps. It is usually done by pushing a fine-hair-like section of mercury out of a capillary tube such as is used in thermometers, by a calibrated insertion of a wire the size of the capillary.

All modern mercury lamps used directly, or with some color improvement by fluorescence, for industrial, flood lighting, and street lighting applications



Phosphors have been developed which convert the energy of the ultraviolet and some of the violet (4047A) and blue (4357A) lines to a deep red fluorescent light.

are the high and limited pressure type. They are made in 100, 250, 400, 700, 1000 and 3000-watt sizes, in a variety of bulb or tube shapes and sizes, and some with integral reflectors.

Color Modification by Fluorescence

It has long been the practice to improve the color rendition under mercury illumination by the addition of an equal wattage in incandescent lamps. The incandescents also provide standby illumination during the several minutes taken by mercury lamps to re-start after a current interruption. For use in places where service interruptions may not be a problem and where maximum efficiency consistent with improved color rendition is desired, the improvement may be secured by fluorescence.

Inside the higher pressure mercury lamps, the quartz glass arc produces ultraviolet of wavelengths from 2400 to 4000Å, which have an energy content equal to that of the four visible lines and double that of the two lines which provide 95 per cent of the lumens, but the ultraviolet lines contribute no lumens to the output. Phosphors have been developed which convert the energy of the ultraviolet and some of the violet (4047Å) and blue (4358Å) lines to a deep red fluorescent light with a conversion efficiency comparable with that of earlier phosphors for the 2537Å ultraviolet. This addition of red and partial suppression of visible blue-violet provides a worth while color improvement. Such phosphors are used in two ways, either as a complete coating on the inner surface of the glass bulb of the mercury lamp or only on the reflecting surface of a reflector type glass bulb. As a complete coating, the phosphor diffuses all of the light from the inner mercury arc and absorbs some of it, but adds enough light by fluorescence to offset much of the absorption. As a coating on only the upper surface of a reflector type bulb it transmits and reflects the upward and horizontal components from the mercury arc and adds fluorescent red to the reflected as well as the transmitted light. In such a lamp the light downward from the mercury lamp is unabsorbed. The result is color improvement with an efficiency which exceeds that of an overall coating by enough to more than offset the losses usually inherent in a reflector type of lamp.

Mercury Lamps Offer Unique Advantages

Modern mercury lamps combine the compactness and high wattage possibilities of incandescent lamps with the efficiencies and long lives of fluorescent lamps. They are inherently adaptable to far higher voltage supply lines than are suitable for use with incandescent lamps. This combination of characteristics makes mercury lamps of unique value in high bay industrial, and street lighting, and flood lighting applications where high mounting permits high wattage units, where replacement labor can be minimized by a small number of units, and where exact duplication of either daylight or incandescent color rendition may be unimportant.

[EDITOR'S NOTE: This article is one of a series on the characteristics of materials and services relating to the lighting industry. Previous articles in this series are: "Characteristics of Plastics," December 1951; "Characteristics of Porcelain Enamel," July 1952; "Characteristics of 300-Degree White Baked Enamel Finishes," February 1953; "Characteristics of Alzak Aluminum," March 1953; "UL — and the Lighting Industry," July 1953; "Characteristics of Tungsten," August 1953; "Calculating Sound-Absorbing Effect of Acoustical Baffles in Lighting Systems," September 1953; "Characteristics of Phosphors," May 1954; "Characteristics of Lighting Glassware," June 1954.]

INSTALLATION AT LIBERTY FEDERAL SAVINGS AND LOAN ASSOCIATION,
202-04 North Broad Street, Philadelphia.

Lighting a Bank

LIGHTING OBJECTIVE: To provide general illumination attractively yet in sufficient quantity for all customers, tellers, and interviewers.

GENERAL INFORMATION: The main banking area shown above measures 61 x 44 x 11½ feet. Height to bottom of cove is 10 feet 2 inches. Reflectances, colors and brightnesses of room surfaces are as follows:

ceiling	off-white	80% RF	19 ft-L
walls	green-gray	80% RF	21 ft-L
floor	terrazzo	35% RF	31 ft-L
carpet	rust	9% RF	12 ft-L
furniture			
top	gray	20% RF	15 ft-L
sides			5 ft-L

INSTALLATION: Six continuous rows of recessed troffers (Keystone TG296-4) each containing two T-12 standard cool white fluorescent lamps operated at 430 ma are spaced as shown in Fig. 2. The cove around the customer area contains a single row of the same type lamps. The average illumination is 72 footcandles. Room surface brightnesses are listed above under General Information; luminaire brightness at 30 degrees viewed lengthwise is 890 footlamberts.

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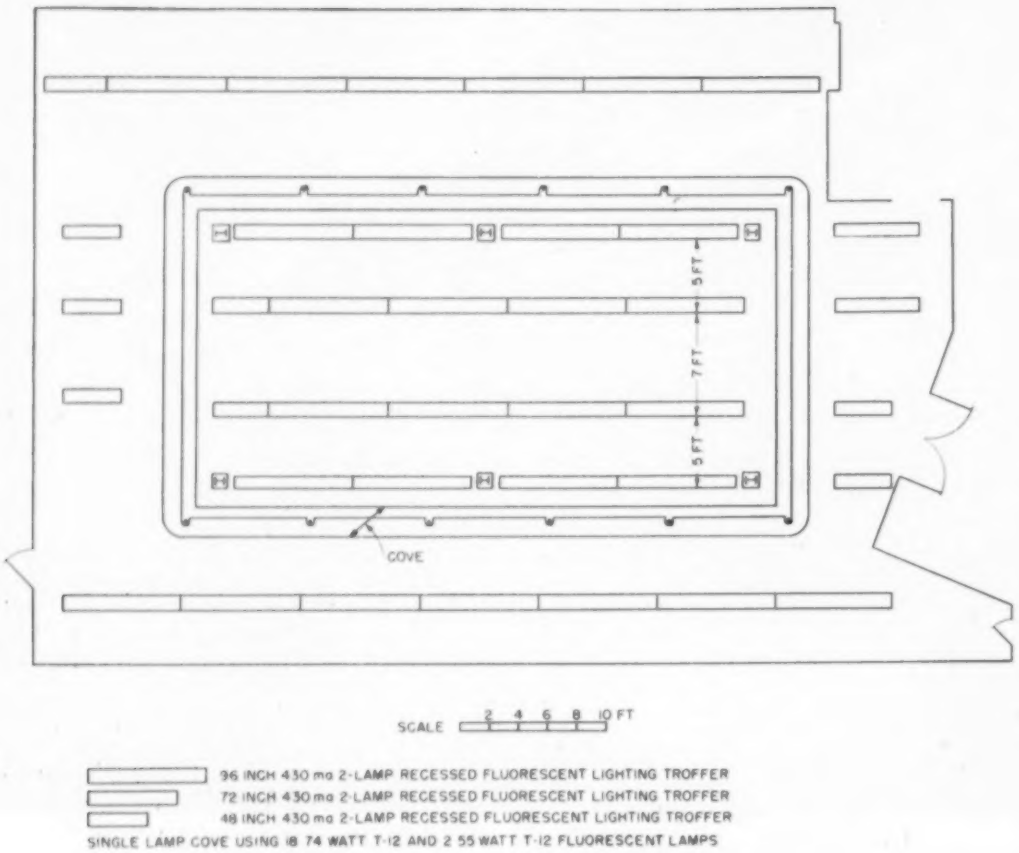

5 FT
7 FT
5 FT
COVE
SCALE 2 4 6 8 10 FT
96 INCH 430 ma 2-LAMP RECESSED FLUORESCENT LIGHTING TROFFER
72 INCH 430 ma 2-LAMP RECESSED FLUORESCENT LIGHTING TROFFER
48 INCH 430 ma 2-LAMP RECESSED FLUORESCENT LIGHTING TROFFER
SINGLE LAMP COVE USING 18 74 WATT T-12 AND 2 55 WATT T-12 FLUORESCENT LAMPS

Figure 2. Plan view showing location of all lighting equipment.

Lighting designed by George T. Anderson, Jr., Philadelphia Electric Company; architect: J. Sindoni; electrical contractor: Ford and Morris.

Lighting data submitted by George T. Anderson, Jr., Philadelphia Electric Company, as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Lighting the Small Amateur Stage

By G. ALLISON LONG, JR.

Purpose

Lighting is one of the primary tools used by the director of dramatic presentations. Together with settings, costuming and properties, it aids the actor, and as Irving Pichell has said, it "helps act the play by symbolizing its meaning and reinforcing its psychology."

The amateur stages to be considered herein may be permanent or temporary. The size is less than 25 feet in width of proscenium, and it is 10 to 15 feet wide with a 10- to 12-foot ceiling height. There are hundreds of these small stages in all parts of the country; in small churches, town halls, lodges and club buildings.

Previous papers and texts on the subject have been directed toward stages of the size found in large schools and in "little theatres." None of them has been aimed at the 10 by 20-foot area.

The amateur using these small stages can be helped materially; first with a modest but effective layout, both physical and electrical, by his architect, lighting service engineer of the utility or manufacturer, or by his electrical contractor when the building is planned or remodeled. Second, he can be helped by being given proven designs of home-made lighting equipment that can be made from materials that are readily available. Last, he can be given advice as to the best way to use the equipment effectively. The resulting satisfaction will prove an inducement for him to procure more adequate commercial devices of greater flexibility.

The amateur who does the lighting on these stages is usually designer, constructor and operator. His expenses are most likely to be his contribution to the "cause" for which the production was staged. He enjoys doing it in order to express himself in a hobby that combines artistic expression, technical ability and construction capability all at the same time.

The illuminating engineer can show the amateur examples of good stage lighting so that his plans can be made with less design error or experimentation. It may not be realized, for instance, that it takes many times the wattage to obtain the same acuity with blue light than it takes with clear incandescent light; that one must resort to the subterfuge of lighting the acting area with more efficient seeing light while the desired color or tone is used on the "set." And on the small stage this requires greater care in design and control of light than on the large stage.

The illuminating engineer can assist the amateur with the latest data on lamps, color media, materials, accessories, and the fundamentals of light control. He can help with simple designs of lighting instruments using the proper materials to satisfy the amateur's needs, in order to provide the quantity, quality and thus the psychological influence that the director desires.

Therefore the purpose of this paper is threefold:

(1) To aid the person who is responsible for the electrical layout or plan.

(2) To aid the amateur in building inexpensive lighting equipment with some suggested designs.

(3) To assist him in using effectively the plan and materials by citing references and examples of its use.

The Electrical Plan

A fundamental requirement of the electrical plan for the small stage is flexibility. Each item should serve as many purposes as possible. If the circuits are permanently connected to footlights, borderlights and spots, there is no possibility of using them for special effects produced by other devices. So each circuit should be individually controllable and terminate in an outlet that can be used for more than one type of lighting or electrical device.

Adequate wiring and grouping of circuits should be provided for safety in a flexible, multi-use system. While building codes define the methods of grounding and fusing, there must be as well provision against excessive overloading of dimmers and against unwanted voltage drop.

The grouping of certain outlets is important on the stage. This is one of the few variations from ordinary interior wiring. Groups of three outlets are used where borders and footlights are most likely to be connected since these contain the three color primaries to do tonal lighting on the stage. Most small stages require only a border at the

AUTHOR: Illuminating Engineer, 1007 26th Road, South, Arlington, Va.

proscenium and another halfway to the back wall. But this must be determined by teaser locations based on a study of sightlines. At the back wall a group of outlets should be located at the side(s) of the acting area to provide for backdrop lighting, special up-stage effects, fireplaces, and portable lamps in interior scenes.

Spotlights are used to light the acting areas, and to create interesting highlights and shadows and points of interest; in contrast to the general flood of tonal lighting created by borderlights and floodlights. Therefore, spotlight outlets are needed in the following locations:

(a) On the auditorium ceiling at a location where the light can be projected to the front of the stage. This light should reach the stage from above the horizontal by as much as 30 to 45 degrees if possible. Here is where physical limitations cause compromises to be made. In some places a false beam can be installed to conceal the equipment, in others the spots can be placed in front of columns. In some of the recent commercial installations no attempt has been made to conceal spotlights, but they are not handsome and the spill light on the ceiling is distracting. What is the number required? We have used as few as two, one opposite each end of the proscenium, but six or eight is a desirable number, each on a separate control circuit. One spotlight outlet is also needed at the rear of the auditorium for a "follow-spot." This can also serve for movie and slide projectors.

(b) On stage, spotlights are needed back of the proscenium arch. There should be enough outlets to permit the use of four to twelve (or more) units on several control circuits. The outlets should be evenly spaced but alternately controlled if more than one is on a control circuit.

(c) On stage, spotlight and general utility outlets are needed along the sides of the acting area to provide for special effects, entrance floodlights and properties.

Footlights may be omitted from small stages. They are only needed for chorus dancing and the small stages being considered here are not large enough for this. If this type of lighting is needed, a portable border strip can be set on the apron and plugged into the utility outlets.

Stage circuits are actually nothing but permanently installed, legally protected extension cords. The type of outlets and the type of wiring will depend on the individual installation. Floor type outlets are convenient but collect dirt (since the screw tops are nearly always lost). The triple outlet in a single sectional box has been found to be most useful and economical. The feed end of each "circuit" should terminate at the control board location in a distribution panel. Using adequate fittings, it should terminate in a flexible cord and plug. (Other systems using patch cords or cross-over plugs have parts that get lost.) Overload protection may be provided on each of these control circuits or in the control board where they are plugged in, in groups or singly. These cords from the distribution panel are plugged into the control panel in the most desirable grouping for easy manipulation on cues from words or actions during the production.

Houselight circuits should be controlled from the control board location backstage. Where wall-switch control at entrance doors is desired, the feeder can be broken and a control leg taken to the control panel. At the panel, the necessary dimmer and its shorting switch can be inserted so that control of the houselights may be exercised backstage during a production. It is desirable to use dimmers on the houselights in order to provide for adaptation of the eyes of the audience before the curtain opens for the scene.

The load on each one of the circuits on the small stage is not large. In fact, the total demand is not large. In the Hamilton installation discussed below, the main is a 120-volt circuit protected by a 25-ampere circuit breaker. It has always been adequate. The board used by the Mt. Vernon Players has a 240-volt main protected by 30-amp fuses, but the stage is of a size and shape that requires more connected load for adequate coverage. In general, the total demand on these small stages seldom exceeds 3 kw although the total connected load may be at least three times as great.

Control Boards for Small Stages

The purpose of the control board is to provide switch and/or dimmer control of each lighting instrument or group of instruments.

Design criteria for the electrical control of stage lighting should be based on simplicity of manipulation during the performance. Many professional installations provide this by fingertip control of direction and intensity at remote locations. Second to simplicity, for the amateur, is economy of installation. Between the extremes of "human engineering" design and of catalog knowledge will lie the acceptable compromise design.

Flexibility in the grouping of stage circuits into various combinations is essential for simplicity of operation. The control grouping of stage lighting instruments will be different for each show. It is believed that the simplest means of obtaining this flexibility is the plug-in system mentioned above.

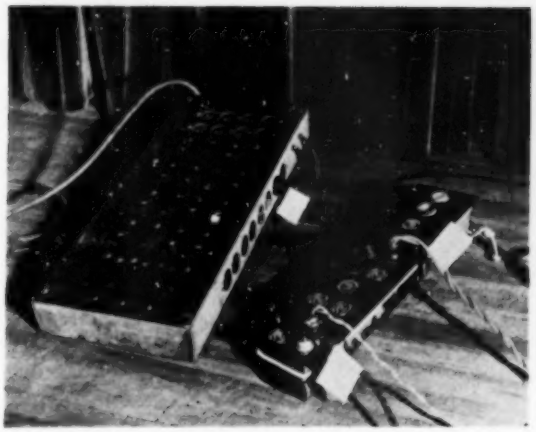


Figure 1. (left) Portable control board; (right) portable plug-in board for minimum requirements.

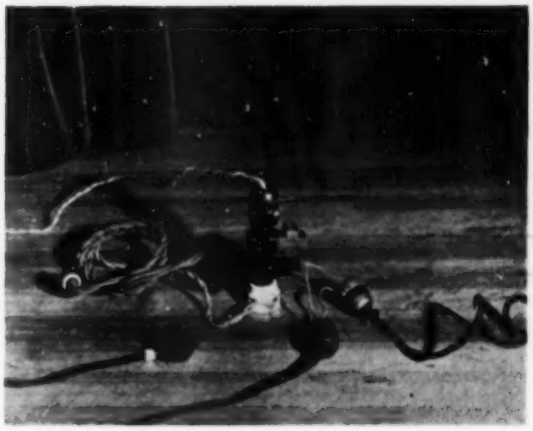


Figure 2. Plug-in board accessories.

The switching and dimming of each group of outlets can then be made on the operating face of the control board. The layout of the board may yield to economy but adequate rehearsals can make up for some shortcomings if the controls are all there.

The arrangement of controls should be aimed at getting the greatest simplicity of operation. The operator usually has to handle them in the dark, or find them automatically while watching for his cue. Rapid changes of lighting may require many manipulations at once and although technical rehearsals will smooth out the rough spots, the ultimate operation is limited by the control design. Let's stop and look at several boards that have been used.

The portable board shown at the left side of Fig. 1 is a combination of distribution panel and control panel. It was designed and built by William Franz at Hamilton (Baltimore) and has been in use since the thirties, and in many places. The panel of masonite is equipped with standard house wiring fittings. A 14/2 main feeder and appliance cord cap has always been adequate. The wiring layout of this board provides for multiple circuit use of dimmers, that is, switching is available to change a dimmer from one circuit to another (at no-load or full-up position of course) without unplugging and replugging. Load outlets are on the side of the cabinet to get cords out of the way. Distribution panel grouping is available to the top of the panel. Control circuit fuses are along the left side of the cabinet.

A small portable plug-board, shown at right in Fig. 1, is constructed with sectional switch boxes and standard fittings. The faceplate was punched to fit. Sectional switch plates could have been used but would not have been as rugged as portability required. Each of the lower two duplex convenience outlets is in series across the line with a single outlet to permit the use of dimmers on these outlets. Grouping is accomplished by means of three-way cubes: several spots or floods may be so grouped as long as the total load does not exceed 600 watts. Accessories used with such a plugboard are shown in Fig. 2. To connect a resistance type dimmer to a cube arrangement, a series connection can be made up similar to the one shown at the lower right in the figure.

The extension cords must be plainly marked when using these minimum boards; gummed labels or masking tape are the usual means. Careful rehearsals are required to make sure that the sequences can be followed and one circuit changed without disrupting one that is in use.

Several control boards were evolved for the installations discussed below. Each is constructed with standard house wiring fittings. Each is arranged to provide the maximum of flexibility permitted by the cost. Each may be set up for rather simple manipulation. These and their associated electrical plan are specific examples of how the ideas presented herein have been used.

The first example is the design for a stage in a church social hall located in a thinly populated area near Baltimore. The auditorium is about 28 feet by 42 feet. The stage is about 13 feet 6 inches deep, 19 feet wide and has a 12-foot ceiling height. The control panel wiring diagram is shown in Fig. 3. All stage circuits are brought into surface mounted 3¼-inch deep outlet boxes which constitute the distribution panel. Each of the boxes is equipped with covers having bushed openings to

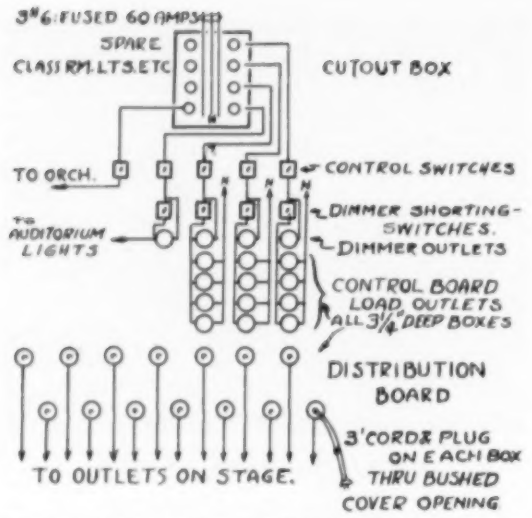


Figure 3. Stage control and distribution boards using commonly available fittings.

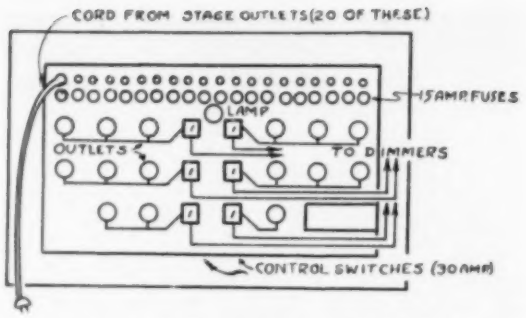


Figure 4. Stage circuit control panel—St. Thomas Church Parish House.

permit the circuit to be brought out in a two-conductor cord terminated with an appliance cord cap. Each cord is long enough to reach any load outlet on the control panel. This control panel has three sets of duplex outlets (in deep boxes) connected in series with the dimmer outlet (and its shorting switch). The whole circuit (set of outlets) is controlled by a toggle switch. With this arrangement, two dimmers will suffice for the entire board. This layout is easy for the electrician to install, no special parts are required and maintenance is minimum.

The location of outlets on the stage is similar to that shown for St. Johns-of-Hamilton and need not be treated before discussing the latter installation.

The second example is the control board for the Parish House, St. Thomas Church, Garrison Forest, Baltimore. The stage is 14 feet 6 inches deep with a 21-foot proscenium width. The electrical plan provides for three border strips, footlights, and eight additional outlets for spotlights and floor outlets on the stage. In this case, the twenty fused stage circuits are brought to flexible cords at the top of the control panel. Dimmers are wired (and fused) directly into four control circuits. Two of the control circuits have no dimmers. The audi-

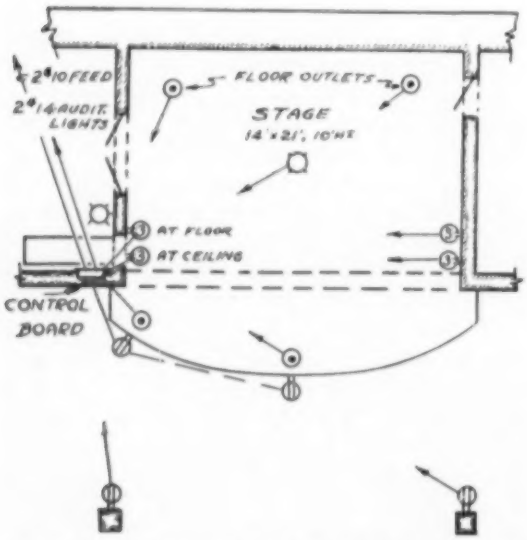


Figure 5a. Stage lighting plan — Social Hall, St. Johns-of-Hamilton, Baltimore.

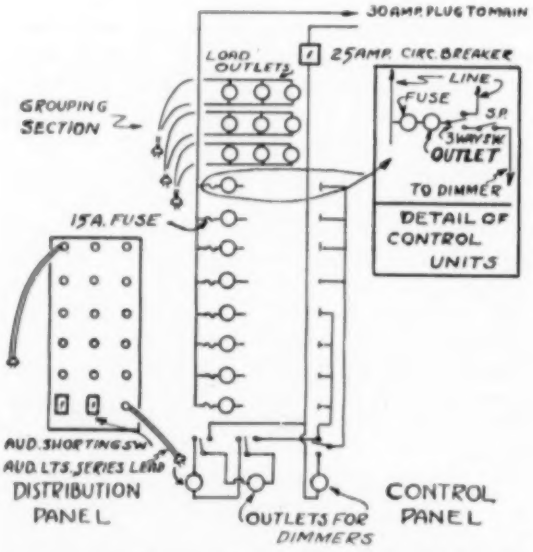


Figure 5b. Control board for a small stage (St. Johns).

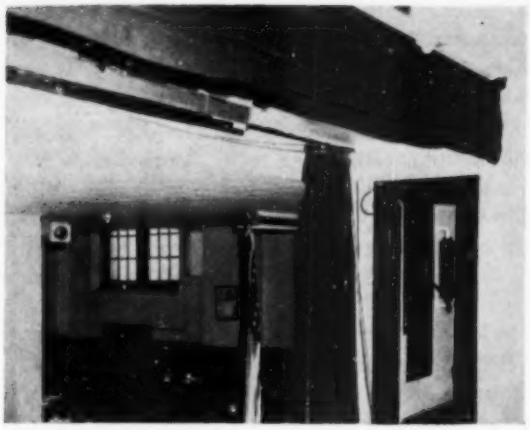


Figure 6. Actor's view of house spotlight, border trough, and control board at St. Johns.

torium dimmer is connected in the main feeder to the auditorium lighting panel.

The third example is from the Social Hall at St. Johns-of-Hamilton, Baltimore, Maryland. The stage is 14 feet deep, 21 feet wide and has a 10-foot ceiling height, as shown on the plan, Fig. 5a. The control board wiring is given in Fig. 5b. This originally had a center ceiling outlet equipped with an enclosing globe, and one circuit of footlights controlled by a switch. The revised installation is shown on the plan. Triple outlets in single sectional boxes are used at each side of the proscenium, both at floor and ceiling. Note the "house spotlight" outlets located at the pillars. This can be seen in the photograph, Fig. 6.

The control board (control panel and distribution panel) is pictured in Fig. 7 and has the following peculiarities: all control circuits can be connected to either of two dimmers by the combination of three-way and single-pole switches. One of the dimmers also doubles for house-lights dimmer through the lock type switch control. The entire board was constructed with P & S Despard Line materials, except the "Main" which is a 25-ampere circuit breaker on the 120-volt feeder of two #10 wires in conduit. Simplicity of operation requires careful grouping of load, and technical rehearsals. The operating platform is hinged and folds up into the doorway when not in use. During the performance, the operator is out of the way of actors and scenery.

The final example is from the stage of the Undercroft Auditorium of Mt. Vernon Place Methodist Church in Washington, used by the Mt. Vernon Players. The stage is about 14 feet deep with a proscenium width of about 25 feet. Concrete ceiling beams come within 9 feet of the floor. The electrical layout is as follows: five circuits on the stage ceiling, each running the full length from right to left with five and six outlets on each circuit. There are four spotlight locations on the auditorium ceiling and one in the projection booth. Additional circuits and outlets are located near the floor at the proscenium and at the rear wall of the stage. All circuits are brought into a standard switch panel, into which the control panel is connected when in use. Dimmer control is provided by 10 autotransformers (2 kva Powerstats) mounted on a portable table. Each dimmer is equipped with fuse and heavy duty cord for connection to the desired circuit in the switch panel. One dimmer on the board is connected into the auditorium lighting circuit during a performance.

Lighting Equipment

Light control by means of spotlights and floodlights provides the interesting highlights, shadows and differences in color intensity that give tone to the scenes. While the use of lens and reflectors increases the efficiency of the instrument, the amateur usually has to resort to other means. He has several things in his favor. First, since his stage is small, the distance from instrument to object lighted seldom exceeds 25 feet and is usually less than 10 feet. Thus the candlepower requirement is not high. Second, his show will usually run only one or two performances plus dress rehearsal, so he can use overvoltage and short life lamps to gain high lumen per watt output. The photoflood lamp

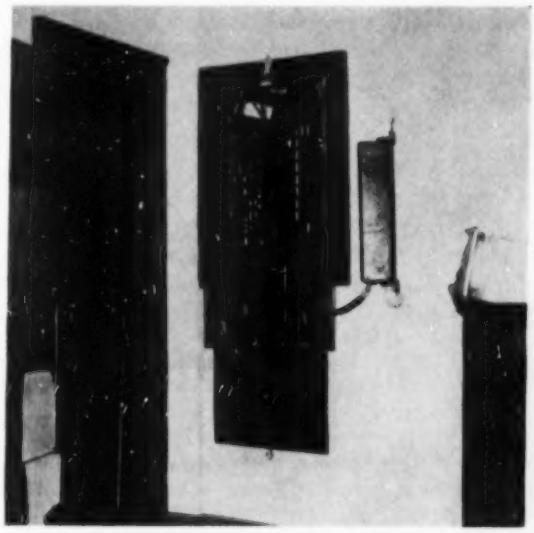


Figure 7. Control board and gallery at St. Johns.

Figure 8. (left) Aluminum cone reflector of heavy Reynolds Wrap; (center) stovepipe spotlight; (right) two-lamp tin trough, shown with one #1 photoflood and one #2 photoflood.

is one answer to this. Third, he can use materials that can be practically formed in place, such as Reynolds Wrap, for when the show is over he can discard it.

Reflector lamps, both spot and flood, with adjustable adaptor sockets are really the amateur's most useful lighting tool. Commercial color frames that clip on the lamp can be modified for use with gelatin by soldering a gelatin type frame to the front of the clip frame. Concentric louvers can be made from dull black sheet iron and added to these frames to reduce the lightbeam diameter.

Floodlights are used to provide either broad coverage or shadowless lighting. Border strips are large area floodlights and to obtain shadowless light from them there should be at least nine or ten lamps per color. Smaller area floodlights, other than reflector lamps can be made of aluminum cake pans or Reynolds Wrap cones equipped with photoflood lamps. Frosted gelatin can be used on these to reduce the sharpness of shadows. In many neighborhoods the camera fans can lend their floodlights for a short time.

A two-lamp trough has been very useful on small platform stages for simple general floodlighting. It may be lamped with 150-watt lamps or with photofloods. At right in Fig. 8 there is a #1 photoflood in one socket and a #2 in the other. The reflector is tin tacked to wooden ends. A dimensioned cross section of this trough is given in Fig. 9.

Photometric distribution curves for the stovepipe spot, Reynolds Wrap cone, and the short trough are shown in Figs. 9, 10 and 11.

The intensity of illumination used on stage is given by Stanley McCandless in his paper on "Lighting for the Audience," ILLUMINATING ENGINEERING, August 1951. On the acting area of the usual interior (room) set the illumination will average 10 to 20 footcandles. Illumination on the

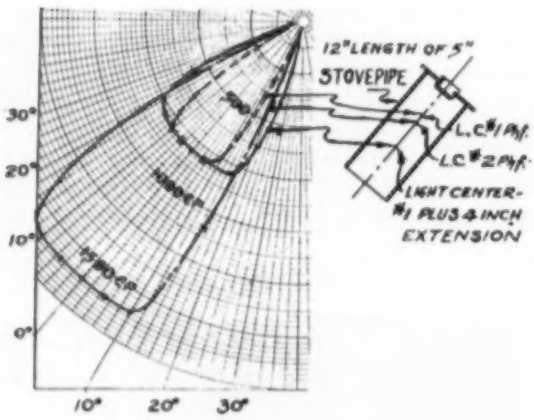


Figure 9. (above) Stovepipe spotlight using #1 and #2 photoflood lamps.

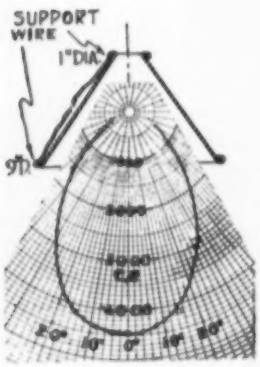
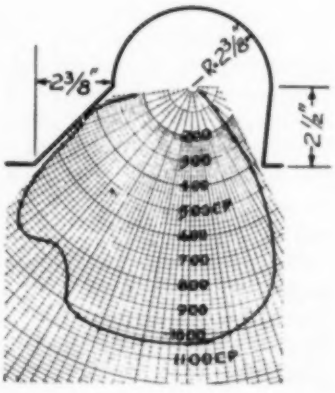


Figure 10. (left) Aluminum cone reflector — #1 photoflood lamp and heavy Reynolds Wrap.

Figure 11. (right) Two-lamp tin trough — c.p. for one #1 photoflood lamp.



acting area for outdoor scenes will vary from less than 5 footcandles for moonlight to 50 for sunlight and then 100 footcandles or more for comedy and musicals where small detail needs to be seen quickly by the average myopic in the audience. But the illumination on the walls of room interior sets should not exceed 0.1 to 10 footcandles depending on the contrast desired, the detail to be seen and the color to be used.

Calculation of the illumination for the stage, to determine lamp size for borders, etc., may be done with the factors shown for show window lighting in the *IES Lighting Handbook*, Second Edition, pp. 9-29 to 9-31.

Colored light is obtained by modifying the incandescent light with color media such as theatrical gelatin, transolene, colored glass or lamp dip. Color frames to hold the theatrical gelatin may be made of any material that is firesafe. The frames are double so that the gelatin is held between two similar frames. Fine wire is laced across each frame or chicken wire soldered to the frame to support the center of the gelatin and prevent damage to it. Theatrical gelatin can be obtained in over 100 colors and tints to suit the needs of costume, scenery and tone. Theatrical gelatin transmits approximately as follows: Red, about 5 per cent; green, about 20 per cent; blue, about 1 per cent; and amber, about 50 per cent. But, in general, to obtain adequate color comparable to unmodified lamp light the wattage should be multiplied approximately as follows: red, about 5 per cent; green, 5; and blue, 15 times. These factors are for gelatins of rather deep chroma and will be less for the tints that are usually used.

Lighting performance and lamp data for the projector and reflector lamps are given in lamp manufacturers' bulletins which give footcandle values for various areas and distances, for the different lamp sizes available.

Light and Seeing

The stage is a canvas on which the lighting designer mixes his intensities and hues to create the desired composition. The mobility of the medium is intriguing. In simplest terms, the designer controls quantity and quality of light to produce psychological influence in the audience.

The discussion of this subject is given in more detail in the paper by McCandless referred to above, and in such books as "Stage Lighting" by J. Fuchs, "Stage Scenery and Lighting" by Seldon and Sellman, "Worship through Drama" by Alexander and Goslin, and others.

Quantity of light determines the visibility and thus the amount of detail which can be seen at a given speed of seeing. Thus, the quantity of light may be used to reveal and aid, or conceal and confuse.

Quality of lighting is determined by color, direction, mobility and overall distribution or composition. It creates realism, aids in supporting the impression of time and locale and helps to set the mood of the scene.

The influence on the audience produced by the quantity and quality of the lighting "reinforces the psychology" of the dramatic presentation. It helps set the tone and mood of the scene and gives it realism. Its mobility lends itself to plastic expression that no other artistic medium can produce. Deftly handled, its supporting action will be unnoticed by the audience.

A favorite example used by A. L. Powers of the old Edison Lighting Institute was about the dueling scene from Shakespeare's "Macbeth." The audience laughed at the first performance when the scene was lighted so that all the action could be seen. The desired result was obtained when the duel was spotlighted from the side, producing sharp contrasts and long, deep shadows. The imagination of the audience supplied what the eye could not see.

"Dust of the Road" by Kenneth S. Goodman is set in the living room of a midwestern farmhouse at midnight on Christmas Eve. A mythical Judas is the central character during most of the act. While he is on, a feeling of "there's dirty work at the cross roads" should be created. This was done in silhouette (first time by accident) with solid shield sconces at the back wall, a shielded firelight in the hearth up center and well-shielded portable table lamp on a table at the rear of the set. No front lighting was used during the scene when Judas was present, for imagination painted a better picture of him than the make-up artist and costumer could ever portray.

In contrast to these, a bright airy mood is desired for such as the wedding scene in the last Act of "Family Portrait" by Coffee and Cowen. The scene is outdoors, just before noon, Judean locale. This calls for canary yellows in the spots, and special lavender for shadows with highlights of dark straw for sunlight to support the joyous mood of the scene.

"From the Record"

Necessity has evolved the simplest of the devices deseribed here. For instance, some years ago at a youth assembly in a mountain resort, a rather effective pageant-drama was planned. Just before dress

rehearsal the director was informed that the lighting man and his equipment would not be present. A quick survey of the nearby community revealed only wares for farm requirements. The stovepipe spots and cakepan floods were evolved. Salt water dimmers were used. Bulb snatching was the order of the day. The rustic setting was matched by rustic instruments. The show was a success.

The one-act play, "Dust of the Road" referred to above was requested by a church in Aberdeen, Md., after some of their folks had seen it presented in Baltimore. So the cast from Baltimore arrived on Sunday evening assured that everything would be ready. The 10 by 12-foot platform extended into the room with two bracket lights on its back wall as the only source of illumination. So shields were cut from suit boxes and placed in front of the brackets and the silhouette effect described above was created.

Several outdoor pageant-dramas were presented by the Drama Guild of the Baltimore Federation of Churches at the Lake on the McCormick estate in Baltimore. One was Longfellow's "Hiawatha" adapted by Mrs. Long, and the other was Osgood's "Sinner Beloved." Since lighting equipment could not withstand overnight, outdoor weather, technical rehearsals on site could not be held. In each case the map of the acting areas was drawn on the control board and the dimmer controls were spotted on the map at the areas they affected. Rapid manipulation was easy and natural. The lighting layout used, in this case, is a long story that cannot be covered here.

Stained glass windows are desirable to give grandeur to the Cathedral scene in Elizabeth McFadden's "Why the Chimes Rang." At Hamilton, Robert L. Iglehart made these of tracing paper to which colored Christmas wrapping tissue was glued and then "leaded" with thick black oil paint. These windows were about 2 feet wide by 7 feet high. A white scenery flat was set up about 2 feet behind each of the three windows and flooded by two #1 photoflood cakepans. This Cathedral scene is back of the gauze drop, so the windows were brought up on dimmers as the front (hut) scene was dimmed out. Following this, the interior of the Cathedral scene was brought up on dimmers and was lighted by stovepipe spots equipped with variegated gelatin to create the illusion of sun beaming through unseen stained glass windows, upon the altar and white-robed clergy.

"The Spreading Flame," a multi-scene historical pageant-drama of American Methodism, written by Harold Ehrensperger was directed by the author at the Lyric Theatre, Baltimore in October 1934. The Epilogue requires "a dais, on which is a large bowl from which comes a flame." "Props" supplied the dais and bowl but whence the flame? Low on an off-center post within the bowl was set a 1500-watt outdoor type 20-inch floodlight pointing upward. Several inches above the floodlight a "dark straw" color frame was fastened. Next above this an 18-inch wall fan was set to blow upward. Some 6 inches above the fan a frame was fastened and fitted with ½-inch wire mesh to hold the 12-inch to 36-inch silk streamers trimmed to simulate a flame. It was necessary to insert an eggrate louver between the fan and the wire mesh to eliminate the swirl in the airflow and make the longest streamers ripple upward. A white flat, 6 by 32 feet, was placed behind the dais to pick up the direct and reflected color of the flame and enlarge on its flickering effect.

One is led to the conclusion that for those who are interested in "The Care and Feeding of Hobby Horses," lighting the amateur stage can provide a whole stable full. If the amateur is given the fundamental laws of light and the effect of lighting he will evolve interesting and intriguing results. Illuminating engineers are in a position to aid him with ideas for installation, control and instrumentation. Intelligently handled, simple devices on his small stage can be used to aid in the production of artistic gems.

I.E.S. National Technical Conference

September 13-17, 1954 — Chalfonte-Haddon-Hall Hotel — Atlantic City, N. J.

Advance registration blanks for the Atlantic City Conference have now been mailed to all I.E.S. members; early return of these forms is to everyone's advantage. So make definite plans now to attend this important meeting. Registration blanks should be returned to the I.E.S. Headquarters Office, 1860 Broadway, New York 23, N. Y.

Some Individual Treatments In Engineering the Installation

The "My Most Interesting Lighting Job" contests held yearly by the I.E.S. Sections and Chapters not only offer national recognition and prize money to the winning entries, but also bring to light many excellent installations which might otherwise be known only to the satisfied customer. For example, among the nineteen entries in the Chicago Section's contest this year, only one could win first prize, but other fine installations were brought to public notice by the contest, among which are those shown on these six pages, chosen to demonstrate some engineering techniques that supplied answers to lighting problems.

S. H. Arnolt's

Two major objectives in store lighting are (1) to provide sufficient light in display windows to compete with adjoining stores on a business street and minimize street reflections in the windows, and (2) to achieve a comfortable selling environment for the interior with highlights on the indoor display.

J. Stewart Stein, partner in Sobel and Stein, Architects, made use of one basic general technique in meeting these objectives in three installations which he entered in the Chicago MMILJ contest, in each case adapting and supplementing the design for the particular requirements of the individual store.

General illumination in each of these installations is provided by ceiling-mounted 4-foot-square 8-lamp louvered units, with additional equipment for higher levels and display lighting dictated by the specific job. Show window lighting in each case made use of the 150-watt recessed reflector spot with fluorescent troffers, downlights or other units added as was necessary.

Foreign cars are small, when compared with most American models, but they might still be considered as fairly large pieces of merchandise. And the owner of S. H. Arnolt's automobile sales room for foreign cars wanted extra light over the automobile displayed in the window and also spot lighting of each auto in the sales area. This was accomplished by mounting behind each of the twelve square louvered fluorescent units a ceiling mounted 150-watt spotlight, with a resultant 100 footcandles on each car. General illumination in the sales area is 50 footcandles.

In the display window, recessed reflector 150-watt spotlights handle the transition from exterior daylight to interior lighting and minimize street reflections, while surface-mounted "cans" highlight the car of the week.

Fell Shoes

In Fell Shoe Store, in suburban Highland Park, Ill., Mr. Stein specified five square louvered luminaires, using standard cool white lamps, supplemented by recessed 150-watt PAR-38 reflector lamps, providing 50-60 footcandles in the sales area. Suspended "cans" with 150-watt R40 floodlamps over show cases raise the level there to 100 footcandles. Over the handbag and shoe wall display, three continuous louvered fluorescent units, with two 40-watt lamps each, are recessed in a section furred down to window height.

In the display windows, 200 footcandles general illumination is provided by similar louvered recessed units, plus recessed reflectors using 150-watt PAR-38 lamps. With the addition of R-40 150-watt spots, certain displays can be highlighted to 350 footcandles, which fairly well takes care of street reflections.

As an imaginative and attractive touch at the store entrance, the plastic domes with hanging plants in the lobby ceiling are illuminated from above at night.

The Komiss Company

Mr. Stein's installation at the Komiss Company, moderately-priced women's wear shop, won for him the second prize in the Chicago contest.

The store has a high-ceilinged front section; and in the rear a mezzanine — for credit department and general offices — cuts the ceiling height to approximately half that of the street side of the store. In the high-ceilinged front sales area four of the 8-lamp square louvered luminaires, which supply 30 footcandles general illumination, are supplemented by stem-mounted units containing 150-watt R40 lamps which bring the level over showcases to 100 footcandles. Three 500-watt surface-mounted downlights over the door provide 100 footcandles in that area. Cornice lighting over wall cases and hat bar supplies 60-80 footcandles on merchandise.

Over the mezzanine, two more square fluorescent fixtures, here using six lamps each, plus 150-watt recessed and surface-mounted incandescent units give an illumination range of 25-75 footcandles.

In the sales area under the mezzanine, 4-lamp recessed fluorescent troffer units, using 40-watt lamps, plus the display lighting provide 100-400 footcandles in this low-ceilinged section. Deluxe warm white lamps are used in all fluorescent lighting in the store.

An average of 200 footcandles is achieved in the show windows with 4-lamp troffers and 150-watt recessed spots, some with gimbel rings. Certain displays are highlighted to 400 footcandles with 150-watt R-40 lamps. The window decorator effectively employs colored fluorescent lamps in the troffers to create seasonal coloring and moods.

Michael Shore Advertising

Luminous ceiling and valance techniques using incandescent light sources were the answer to a lighting problem in an executive office of Michael Shore Advertising, located in a direct-current district of Chicago. Albert Bacalar, of Luminous Ceilings, Inc., was the engineer who worked out this solution.

Over the working area, large luminous ceiling panels of a light vinyl plastic diffuser are dropped 1½ feet from the ceiling in a 2-foot-deep soffit that extends at an angle across the office. Above the panels, 60-watt silvered bowl incandescent lamps are arranged in three rows of 7, 6 and 3 lamps respectively, on 3-foot centers, with an additional row of 4 lamps above the desk. An adjustable downlight between the two corner panels provides supplementary illumination on the work area there.

Between the plastic panels, decorative acoustical baffles, of perforated steel painted to blend with the rest of the interior, serve the dual purpose of supporting the diffusing panels and providing sound conditioning.

Behind the sofa, a line of six incandescent lamps is concealed under frosted glass to create a valance effect on the perforated masonite background. The drop light over the sofa is functional, while the four 150-watt reflector spots in louvered downlights are used for the dramatic effect.

Interior design by Warren Wetherell & Associate; electrical contractor, Kelso Burnett Co.

Wilmette Service Office

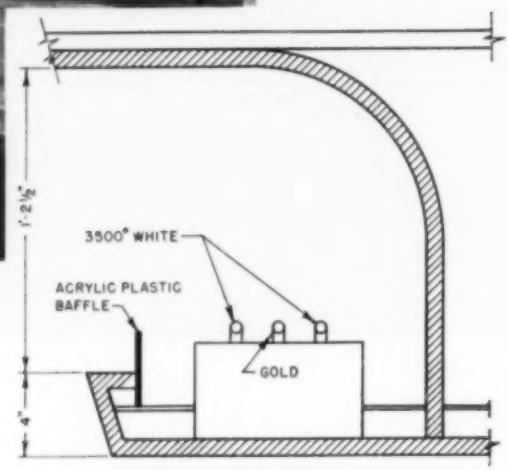
The lighting installation of the Wilmette Service Office of Public Service Division, Commonwealth Edison Company, was, appropriately, planned completely by one of the company's lighting engineers, C. N. Carlson. The job won for Mr. Carlson the third prize in the Chicago Section's contest.

Over the cashier's desk and the lamp case and counter, four louvered metal-sided panels, each with four 96-inch cool white deluxe slimline lamps, are mounted on 30-inch twin stems. The panels have individual top reflectors. In the center of the room are two sphere units on 27-inch stems, containing 150-watt R-40 floodlamps. One lights the 8 x 9-foot mural on the right wall of the office and the other provides additional illumination in the rear of the room away from the window. An indirect wall bracket, with a 100-watt incandescent lamp, is mounted 5½ feet from the floor over a service clerk's desk at the back of the room.

In the front part of the office (not shown in photo), a direct-indirtct double-arm unit is wall-mounted 6½ feet from the floor over a customer's desk near the front window. In the window itself, five recessed aperture downlights with 4-inch openings use 150-watt PAR-38 floods.

The ceiling, 12 feet high, is cocoa brown, and white brick wallpaper is used on the wall with the mural.

Illumination in the cashier's working area and on lamp counter is 165 footcandles.



Detail of cove.

St. Paul Federal Savings & Loan

A specially-designed cold cathode cove, recessed downlights and low-brightness troffers were the choice of Electrical Designer Thomas P. Lalish, of Holabird & Root & Burgee, for the lighting of the banking and general office areas in St. Paul Federal Savings & Loan Association.

In the cove, cold cathode tubing, one gold and two 3500K white, with double-back electrodes, are on dimmer control. Architecturally it was desirable to keep the lip of the cove as thin as possible and an interesting innovation was used to shield from the critical sight line the portion of the socket housing which would show above the rim of the lip. Instead of the usual steel baffle which tends to reduce the effectiveness of the cove, a white acrylic plastic baffle with a transmission of approximately 30 per cent was installed, blending in with the cove. Height of the cove ceiling is 11 feet; and there are 18 200-watt downlights recessed in it.

In the general office areas, troffers with low-brightness lenses, recessed in the 9½-foot ceiling, use Rapid Start T12 lamps. The ten surface-mounted downlights using 150-watt lamps provide supplementary illumination over the tellers.

Downlighting over tellers.

An Ulbricht Sphere for Large Luminaires

By G. H. SECHRIST

Describing a simplified method of making a low-cost 10-foot Ulbricht Sphere for the photometry of luminaires using 8-foot fluorescent lamps.

FOR MANY YEARS the Ulbricht Sphere has been the usual means for comparing the lumen output of an undetermined source with the output from a standard or calibrated source.

With the coming of fluorescent lighting and particularly with the advent of eight-foot fluorescent tubes as one of the standard lengths, larger spheres became necessary. It was this demand for a way to make comparisons of the output of these longer tubes that led to the construction of a ten-foot sphere for laboratory use at the University of Nebraska.

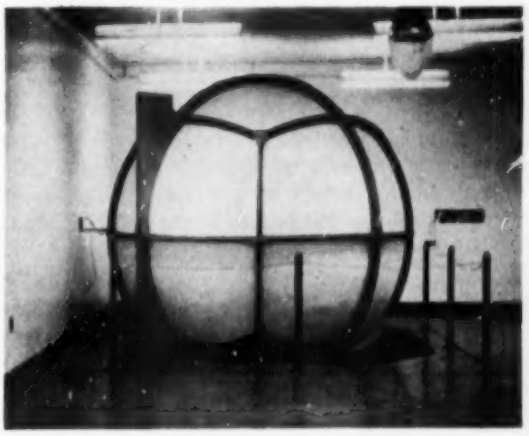
For various reasons, the principal one of which was cost, the decision was made to build the sphere in the departmental shop.

Consideration of the function of the sphere revealed that a wall of eggshell-like properties would suffice to give the desired control of light output from a source. Consideration of accessibility of the interior for suspension of the sources for comparison led to division of the sphere into halves. Ease of opening and closing led to hingeing one half to the other half. A sphere, and to a degree, a hemisphere, is self supporting, but when the opening and closing operations are considered, it becomes obvious that a supporting and stiffening framework is essential.

Aluminum, steel, or some other metal would seem to be the ideal material for the shell of the sphere. However, metal would have to be cast or formed to the spherical shape and this is any case is an expensive operation.

The possibility of using some non-metal was then considered. Burlap, because of its low cost, its strength and ease of shaping over a spherical form, seemed to be a suitable material for the test. When drawn over a convex surface and given a coat of varnish or plastic material, the burlap holds its shape very well.

The final decision was to use a double layer of burlap impregnated with plaster of paris. A four-sided form was built, each side of the form being approximately 48 inches in length. These four sides bounded a convex spherical surface which surface had a five-foot radius corresponding to the inner surface of the sphere. This form was built from three-quarter-inch pieces of lumber, one edge of which was cut to the five-foot radius. Eight or nine of these pieces spaced about six inches apart and joined by cross braces also cut to arcs of five-foot radius, made the framework of the form. Over the convex surface of this framework, a sheet of burlap was stretched and tacked in place. This burlap was impregnated with plaster of paris. The whole was moistened and allowed to set with the convex surface down. This position allowed the burlap to sag more readily to the spherical shape than if placed convex side up. After setting, the irregularities on the surface of the form were filled in carefully to give a true five-foot radius to the convex surface. A sweep board cut with a concave edge of five-foot radius served to produce a form with the desired curvature in all directions. Twenty-four segments, all of the same shape and



Ten-foot sphere constructed for laboratory use at the University of Nebraska.

AUTHOR: Professor, Department of Electrical Engineering, University of Nebraska, Lincoln, Nebraska.

dimensions were required for making up the spherical shell. These were all made on the one form. First a layer of newspaper was placed over the convex surface of the form to prevent adhesion of the sphere segment to the plaster of the form. Next a sheet of burlap was drawn over the convex surface of the form and carpet tacks used to hold the burlap in place. Plaster of paris was then spread over and thoroughly worked into the burlap. A thin layer of the plaster was spread over the convex surface of the first sheet of burlap to form a stiff midrib of plaster in the finished segment. The second sheet of burlap was then tacked in place and the impregnation with the plaster repeated. Water was then carefully applied so as to penetrate both layers of burlap and still not too much as an excess would carry away the plaster. The plaster hardens in a few hours. The tacks can be removed and the segment lifted from the form. By constructing the form with edges having dimensions one-half inch or so greater than that of the desired dimensions of the finished segment, time can be saved since the cured segments can be readily trimmed to size with a pair of tin snips. It is difficult to produce a uniformly good segment right out to the edge of the form. Then too, any damage to the edge incident to handling the segment will eventually be removed by trimming.

As previously stated, twenty-four segments, all alike, were used in making up the spherical shell. The choice of segment shape and size proved to be a principal factor in the success of the project. The segments are approximations of a square, all alike, and of a size to be readily formed and handled in construction. It is difficult to make a drawing showing the method of determination of the segment shape and dimensions. The determination can be readily described, however, if the process of expanding a cube into a sphere is used. This process has the advantage that the important angles as they exist in the cube carry over to the angles in the sphere, and so permit solutions for dimensions of the sphere with a minimum of knowledge of spherical trigonometry.

Consider a cube of such size that its eight corners lie in the surface of a circumscribing sphere which sphere has ten feet as its diameter. Each of the six faces of the cube is further divided into four equal squares for a total of twenty-four for projection upon the inner surface of the sphere. Let a point source of light at the center of the cube cast shadows of the edges of the twenty-four squares upon the inner surface of the sphere. These shadows outline twenty-four segments on the sphere and these segments are alike in form and dimensions. These segments in fact have three corners that are 90° spherical angles, and the fourth corner is a 120° spherical angle. All edges of segments lie in great circles of the sphere.

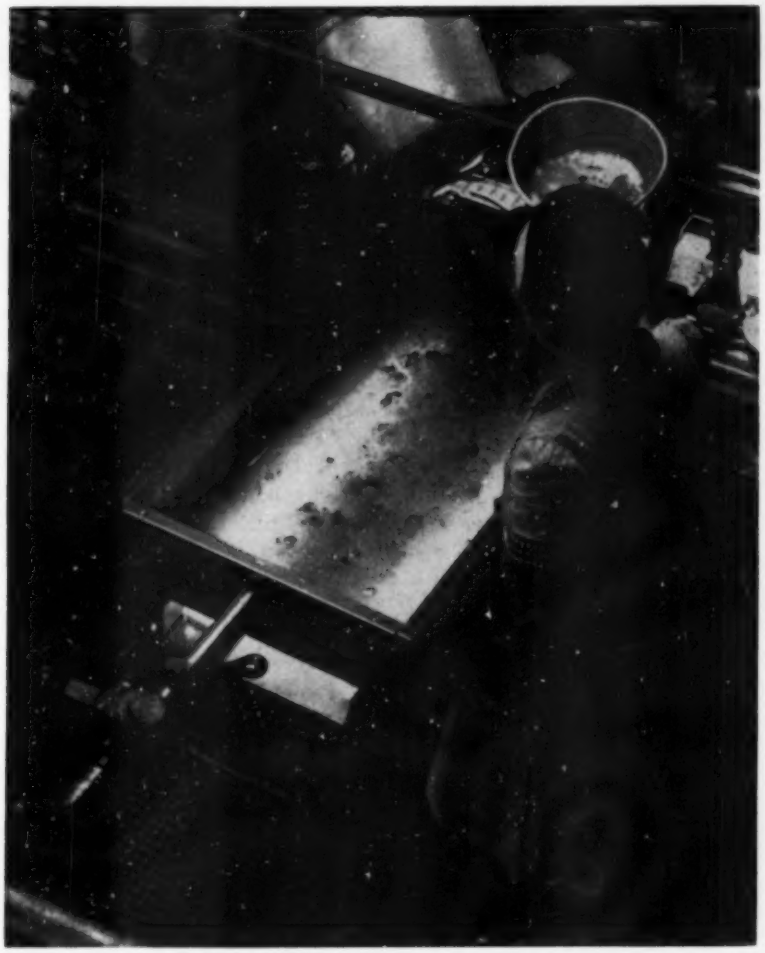
The pattern for the framework was obtained by the same method that outlined the segments of the sphere. The four-inch wide frame members were cut from half-inch thick plywood sheets, four feet by eight feet in size. All twenty-six joints in the framework come at intersections of the members. Eighteen intersections are at right angles and were easily reenforced by nailing in rectangular blocks. Eight intersections, corresponding to the corners of the cube, were of three members each and the reenforcing blocks each had a 120° angle.

In order to hinge the two halves of the sphere together, one of the vertical great circles of the sphere was made a double structure. Wing nuts on bolts were used around the great circle in addition to the hinges to hold the two halves in the closed position while taking readings. All frame members were given additional rigidity by having three-quarter by three-quarter-inch strips nailed to their sides next to the surface of the sphere. The cross section of a frame member with strips is therefore a T with the top of the T against the surface of the sphere.

One-half of the sphere is fixed in position and a steel cable passes through its top so that the weight of the fixtures under test is carried by a beam in the room ceiling. The movable half has casters to carry most of the weight, the function of the hinges being largely to hold the halves in alignment.

A removable segment about ten inches square was made at the center of the stationary half of the sphere. This small segment, removable like a plug of a watermelon, carries a small circular opening for taking readings. A small hole could have been cut in the spherical shell itself and would have served the same purpose without the framing required for the removable segment.

The cost of materials for the sphere was a little more than $100. No check of labor costs was made. The structure, including shell and plywood frame but exclusive of the supporting members in the base, has a weight of approximately five-hundred pounds.



INSTALLATION AT TEA GARDEN PRODUCTS, SAN LEANDRO, CALIFORNIA.

Lighting for Jelly and Jam Inspection

LIGHTING OBJECTIVE: To transilluminate jelly and jam to reveal foreign impurities by silhouette.

GENERAL INFORMATION: Many canned foods are translucent and when they are placed in transparent containers, any impurity or piece of foreign material is readily visible. Although the Pure Food Regulations permit certain finite quantities of impurities the housewife will not tolerate any visible impurity. The factory inspection of jams, jellies and preserves is usually carried out by flowing the product over a stainless steel table with 30 to 100 footcandles incident on the upper surface of the product. Removing foreign material under these circumstances requires highly skilled operators because the foreign material is of nearly the same brightness and color as the sound fruit.

INSTALLATION: The table shown above has a 3/8-inch plate glass bottom, 4 inches beneath which are mounted two 36-inch T-8 deluxe warm white fluorescent lamps. This brings most of the jelly

(over)

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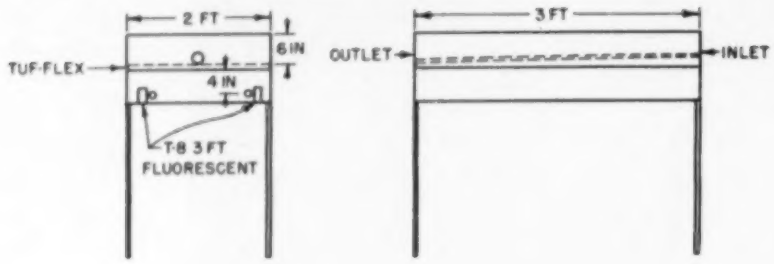

Figure 2. Detail of inspection table lighting.

products to a brightness of at least 20 footlamberts, the minimum desirable brightness. Even though the fruit diffuses the light somewhat, the bottom of the Tuf-flex thermal shock resisting glass was sandblasted to provide more even brightness. Strawberry preserve, a medium dark fruit, exhibited a brightness ranging from 20 to 60 footlamberts, depending on the depth of flow (0 to 4 inches), with foreign objects much darker and presenting a definite color contrast. Under this illumination the inspection procedure is one of detecting and removing dark black objects from a field of slightly glowing red sound fruit. The company found that with this lighting one operator without extensive experience can sort and inspect as much jam as four experienced operators in a similar plant which uses opaque inspection tables.

Lighting designed by Raymond P. Benton, Pacific Gas and Electric Company, Oakland, California; equipment constructed by Brenner-Nawman, Inc., Emeryville, California.

Lighting data submitted by Raymond P. Benton, Pacific Gas and Electric Company, Oakland, California as one solution to a lighting problem and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

A Preliminary Report on —

Physical Processes in the Fluorescent Lamp Which Cause Radio Noise

By HOWARD L. STEELE,* JR.

Several experimental methods of reducing radio interference below that ordinarily radiated have been presented for the purpose of understanding the characteristics of this interference.

THE USE of fluorescent lamps in the home, in areas where radios are to be tested or demonstrated, or on Naval ships has necessitated a study of the radio noise fields generated. The importance of this problem depends on the location of the radio with respect to fluorescent lamps and how much signal there is available from the radio station. The available signal will be low in rural areas or at sea.

There are two fundamentally different ways of attacking the problem of reducing the radiated* noise. First, shunting capacitors, external shielding and line filters can be used to reduce the noise after it has been generated. A second method is to try to prevent the noise from being generated by making fundamental changes within the lamp. The present report is concerned with the latter method. This means that a study had to be made of the physical processes within the lamp which cause noise. The physical processes are associated with various types of oscillations observable in an oscilloscope trace representing lamp voltage. The physics of each process will not be discussed in detail. Instead, it is the objective of this preliminary report to give a comparative evaluation of the magnitude and frequencies of interference radiated by the different physical processes. A discussion will then be given on what experimentally, if not practically, can be done to reduce the effectiveness of the worst offender.

Methods of Observing and Measuring Noise

The oscillations observable in the lamp voltage trace viewed on an oscilloscope are non-sinusoidal. The fundamental frequency associated with the higher amplitude oscillations (they have a frequency of about one kilocycle) is obviously too low to cause noise in the broadcast band. There are high rates of rise or fall in these non-sinusoidal wave shapes so that in order to ascertain what high frequency components are represented, an harmonic analysis is necessary or an experiment must be performed to see if they are causing appreciable radiation at frequencies much higher than their fundamental frequency. In addition, there are less obvious high frequency oscillations in the lamp voltage trace. These can best be examined by filtering out the lower frequency components (especially the 60-cycle part) so that greater amplification can be used. Since these high frequency oscillations are also non-sinusoidal, it is desirable to measure the radiation accompanying each type of high frequency oscillation.

Since some radios are more susceptible to noise than others, standardized methods of measurement must be used if the data on fluorescent lamps are to be compared with that from other sources. A shielded room must be used so that the noise will not be confused with that from other devices even though reflections from the wall result in higher readings than would be obtained in homes. The shielded room used was 6 by 8 by 8 feet on the inside and is made of solid copper sheet outside of which, at a spacing of three inches, is a solid cubicle of galvanized iron sheet. The galvanized iron is necessary to shield against magnetic[1] fields of the lower frequencies.

The meters used to measure noise are essentially sensitive radio receivers provided with a meter indicating the output and means for establishing

*Since the noise is detected at distances very small compared to a wavelength it might more correctly be called induced noise.

AUTHOR: Research Dept., Lamp Division of Westinghouse Electric Corp., Bloomfield, N. J.

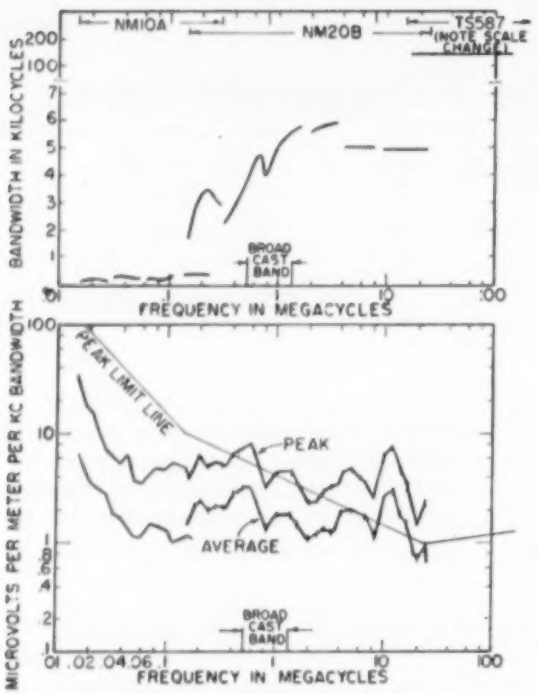

Figure 1. Preliminary information on the three noise meters. Upper: Bandwidth and frequency range covered by each instrument. Lower: Meter noise for two meters and relation to limit line set by Armed Forces.

the sensitivity of the receiver. The Armed Services[2] now specify, and the American Standards Association[3] plans to specify, that these meters should read three characteristics of radio noise: average (field intensity), quasi-peak, and peak. Quasi-peak readings are taken with detector circuits which have specified charge and discharge time so that the response will be indicative of the annoyance to commercial receivers.[4] Although quasi-peak readings were taken in all the experiments to be discussed, they are not presented because the spectra obtained are the same shape and only slightly below (always between half to two-thirds of) the peak spectra.

Noise meters,* NM-10A, NM-20B and TS587 were used which respectively cover the frequency ranges 0.015 to 0.25 megacycles, 0.15 to 25 megacycles, and 30 to 400 megacycles. The first two meters are the civilian equivalent of Radio Test Sets AN/URM-6 and AN/PRM-1 respectively. These two meters are the only two meters currently acceptable[5] on all counts. (Note that measurements were taken over a very wide frequency range compared to that of the standard broadcast band which is from 0.55 to 1.6 megacycles. This helps in attempts to separate the effects of various physical processes within the lamps which cause radio noise.) Since these noise meters read the voltage developed on an antenna of half meter effective height an electric field strength can be calculated. This voltage was read at 18 specified points on the NM-10A meter and 32 on the NM-20B. The lamps were not turned off between readings because restarting can change the spectrum appreciably. The meters were calibrated against an internal shot noise diode at each point.

The resolution of these instruments with respect to frequency (their band width) varies with frequency. Since an instrument with a wide bandwidth would register more voltage from a broadband source of noise than another with a narrow bandwidth, the noise must be expressed in microvolts/meter/kilocycle bandwidth. This type of plotting is the most fundamental providing the noise consists (as will be shown) of high peaks. For random noise the response of the meter would vary as the square root of the bandwidth.[6] The bandwidths of the meters used are given in the upper part of Fig. 1.

The noise meters are run on batteries and the power to run the lamp is passed through r.f. filters (which give 90 db attenuation to all the frequencies covered herein) and through shielded leads. Even if all the radiated noise from the outside is blocked by the shielded room and all conducted noise from the outside is blocked by the filter there is a lower limit for the magnitude of noise from the lamps that can be measured due to meter noise. The lower part of Fig. 1 is a plot of the average and peak reading taken with the antenna in place but with the lamp replaced by a resistance passing 420 milliamps from this filter and shielded supply. The short vertical lines represent the spread in the data at each frequency for 10 sets of readings. Next the current flow was stopped, the antenna was taken off, and all jacks were capped. The spectra obtained in this condition fell within the limits given by the vertical lines and thus as far as could be detected all the ambient noise was due to the meters. This meter noise is assumed to be random and is caused by thermal agitation in the resistance of the input circuit and the tubes used in the first stages of the meter.* It cannot be directly subtracted from meter readings because the meters are not linear. As the manufacturer suggests, the random meter noise was subtracted from the readings in an rms manner. There is some question whether this is correct for the case of the peak

*Manufactured by Stoddard Aircraft Company.

*The manufacturer has recently suggested a means for reducing this meter noise.

spectra. It will be seen, however, that most of the noise is of such a magnitude that it is not necessary to subtract the meter noise except at the higher frequencies.

The noise radiated from a lamp is measured with the antenna one foot above a brass topped table and one foot from, and parallel to the lamp. This arrangement complies with standardization procedures arrived at by the Armed Services.[2] The shielded lead should insure that only the radiation from the lamp itself is detected. Conducted noise will not be discussed. In order not to influence the radiated field all extra wires between ends of the lamp were eliminated. Starting compensators and glow switch starter were not connected.

The Mean Spectrum for Low Noise 40-Watt Lamps

Standard 40-watt lamps can differ by a factor of several thousand to one in the amount of noise they produce in the broadcast band. Lamps of identical structure often vary in the type of oscillations which appear in the oscilloscope trace of the lamp voltage. If lamps with the same structure are selected which, in addition, have the same type of oscillation in the voltage trace the radiated noise spectra may differ by only a factor of four to one. Fig. 2 gives the peak and average readings of two standard 40-watt lamps with each in turn run on both the lead and the lag sides of a conventional pre-heat ballast. These lamps had a minimum of high frequency oscillations in the voltage trace and the spectra are among the lowest found with standard 40-watt lamps. One lamp has been tested with the TS587 meter (30 to 400 megacycles). Part of this spectrum is shown on Fig. 2.

Further sets of spectra should be plotted on Fig. 2 in order to define a good mean spectrum but this would make it difficult to trace the characteristic of an individual spectrum. The spectrum of an individual lamp contains an unexplained fine structure. The two maxima in the upper curve of Fig. 2 (the solid line) at approximately 1.8 and 3 megacycles are part of this fine structure. This structure makes it difficult but not impossible to define a mean* spectrum. It is seen that even with only these four sets of spectra a fair mean can be drawn which would not be influenced by the fine structure of any one spectrum. The peak spectra for four other lamps with the same low noise characteristics were obtained on this and other ballasts. They fell within the spread of the data indicated in Fig. 2.

*The term "average spectrum" was used to refer to the time averaging accomplished by the meter. The term "mean spectrum" will be used to refer to an averaging of the amplitude of the noise.

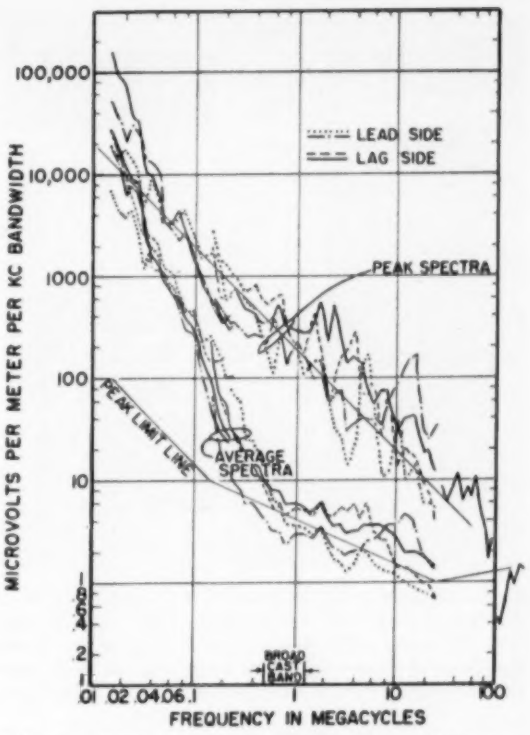

Figure 2. Peak and average interference radiated from low noise standard 40-watt lamps.

The peak and average spectra for a given lamp have the same coding (dashed, etc.), as indicated on the figure. Note that the peak to average ratio was greatest in the broadcast band. Note also that above 0.04 megacycles the mean for the peak spectra could be approximated by a straight line. A straight line of slope of minus one has been added to represent a mean spectrum for the many peak spectra. To the extent which this line represents the mean, the peak noise is thus linear with the reciprocal of the frequency.

The Noise Reduction Needed Commercially

The question, "How much reduction is needed in the most critical installations?" can be partly answered by comparison with the limit set by the Armed Services on peak noise radiated. This limit is labeled peak limit line on Fig. 2. Except in the case of noise measurements on equipment for metal ships, it is meant to apply as a limit in open field measurements. The fact that the measurements reported herein were made in a shielded room makes them too high for comparison with this limit.

As indicated by the following tests on a special

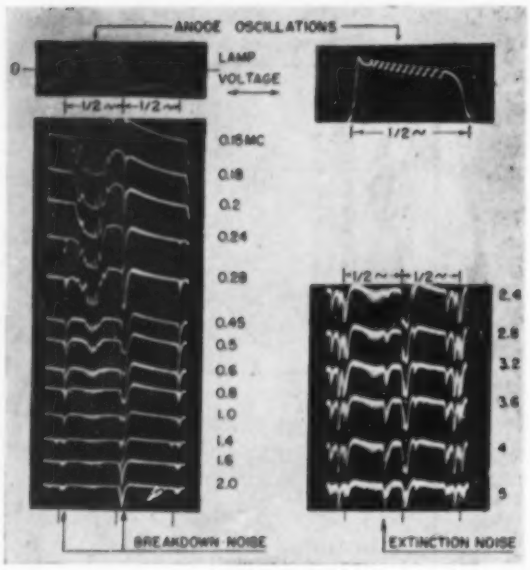

Figure 3. Output of noise meter on oscilloscope as a function of frequency and comparison with lamp voltage trace at lower left. The camera was open for many sweeps by the trace so that the reproducibility of noise on succeeding cycles is demonstrated. Three of the four general noise types are shown.

lamp, this limit is certainly lower than that necessary for the average home.

The noise from a special low noise lamp was found to be about three times this limit in the broadcast band. The effect of this low noise lamp on the reception of a radio station by one particular portable radio was determined by leaving the door to the shielded room open. The radio station was made just detectable by closing the door part way thus simulating weak field reception. With the amount of noise represented by three times the limit line, there was no objectionable interference to stations at the lower end of the broadcast band with the build-in antenna placed one inch from the lamp. Interference with stations at the high frequency end of the broadcast band was detected at one inch but was undetected at six inches.

Types of Oscillations and Their Effect on the Radiated Spectra

The radiated noise is caused by four different types of oscillations which occur in the lamp voltage trace. These are (1) anode oscillations, and (2 and 3) cathode oscillations at breakdown and extinction parts of the cathode half-cycle. The remaining type is a cathode oscillation to be designated (4) twin noise.

A most obvious non-sixty cycle, ten-volt periodicity in the voltage trace is that of the *anode oscillations*. The upper two pictures in Fig. 3 show, respectively, one full cycle and one-half cycle of typical lamp voltage traces. These traces repeat perfectly from cycle to cycle but the two half cycles shown in the trace at the upper left are not identical. The first half cycle has many oscillations occurring at the top of the trapezoidal wave shape while the second half cycle has almost none. The upper right hand trace shows the details of the oscillation better. The frequency of the anode oscillations in this particular case is about 1500 per second. These oscillations have been shown to be associated with the anode by a number of methods. One method was to photograph the discharge. Bright regions have been shown[7] to appear at the anode at a rate corresponding to these voltage oscillations. The bright regions are times of high ion concentration around the anode and correspond to the low voltage part of the anode oscillations. The ion space charge effectively produces a large virtual anode so that a high voltage is not necessary to supply the lamp current from the random electron current available in the discharge itself. Anode oscillations can be prevented by the use of large cylindrical anodes of the proper dimensions.[8]

The influence of anode oscillations at and near standard broadcast frequencies is also shown in Fig. 3. The output of the noise meter was observed on an oscilloscope. The meter was set for average

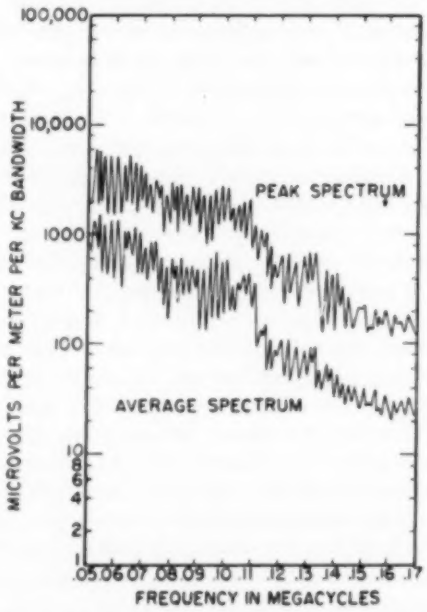

Figure 4. Fine structure in the interference radiated at lower frequencies. Structure is due to harmonics of anode oscillation frequency.

or field strength readings. The amplication was constant from 0.15 to 2 megacycles. Greater but constant amplification was used from 2.4 to 5 megacycles. The lamp voltage trace given at the upper left was taken at the same time with the same time spread and phased to line up with the radiated noise traces below it. The first half cycle for all traces up to 4 megacycles show numerous peaks corresponding to anode oscillations in the first half cycle.

A fine structure in the noise radiated at low frequencies is shown in Fig. 4. It is attributed to anode oscillations. It should be noted by referring to Fig. 1 that the bandwidth of the low frequency noise meter is less than 0.4 kilocycles. This resolution made the detection of this fine structure possible. As one of the spectra of Fig. 2 was being taken, it was noted that maxima were occurring at approximately every 2 kilocycles from 0.015 to 0.19 megacycles. Since the anode oscillation frequency was also about 2 kilocycles it was believed that the noise meter was detecting harmonics of the anode oscillations. The 100th harmonic was detected. The fine structure was more definitely determined to be associated with anode oscillation by use of the large cylindrical anodes. No fine structure was observed with this type anode.

Thus, anode oscillations can radiate detectable noise from about one kilocycle to several megacycles. Further examination of Fig. 3 is of help in evaluating the importance of this type of noise. A peak definitely not associated with the anode oscillations became the most important peak occurring above 0.28 megacycles. A lower peak corresponding to the breakdown of the first half cycle is also distinguishable. This is caused by *breakdown oscillations*. These are not as obvious in the lamp voltage trace but can be detected there. A broadening of the trace often occurs as the voltage reaches about 10 volts. Closer examination would reveal that sometimes this is caused by a hash and that other times it is caused by regular, nonsinusoidal oscillations. The hash or regular oscillation can be shown to be located near the cathode by the use of a probe or with a highly directive photomultiplier. Not enough is known at present about the difference between these two types of breakdown oscillations to make a discussion profitable here. The regular oscillations do increase in frequency with time in the cycle as they first increase and then decrease in amplitude. The breakdown peak for the second half cycle occurs later and later in the cycle going from 0.15 to 2 megacycles. Either type of breakdown noise is definitely more important than anode oscillation noise in the broadcast band. It cannot even be said that anode oscillations are always more important than breakdown noise at the lower frequencies because experiments which influence or eliminate anode oscillation affect breakdown noise. The magnitude of the noise below 0.1 megacycles was not appreciably affected by the large cylindrical anodes although the anode oscillations were eliminated as evidenced by the lamp voltage trace and lack of fine structure.

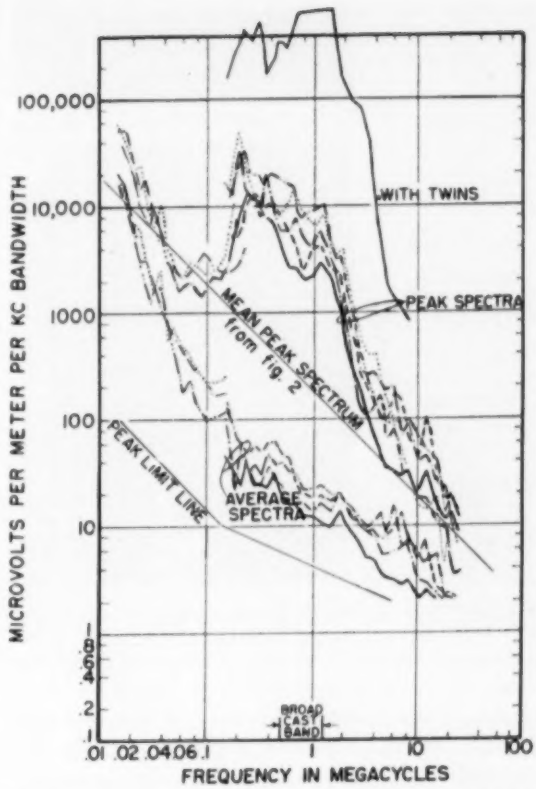

Figure 5. Peak and average noise radiated from standard 40-watt lamps which exhibit high amplitude breakdown oscillations.

Fig. 5 shows the peak and average spectra for lamps containing greater breakdown noise than those of Fig. 2. These lamps were operated on an instant-start ballast which may have caused the conditions producing these oscillations. Lamps operated on the preheat ballast can have the same magnitude of breakdown oscillations and produce spectra comparable to Fig. 5. Note that these oscillations had resulted in a twenty to one increase in the mean peak spectrum in the broadcast band. The breakdown oscillations, unfortunately, are thus shown to have their greatest effect near 0.2 megacycles. The amplitude of oscillation of this fre-

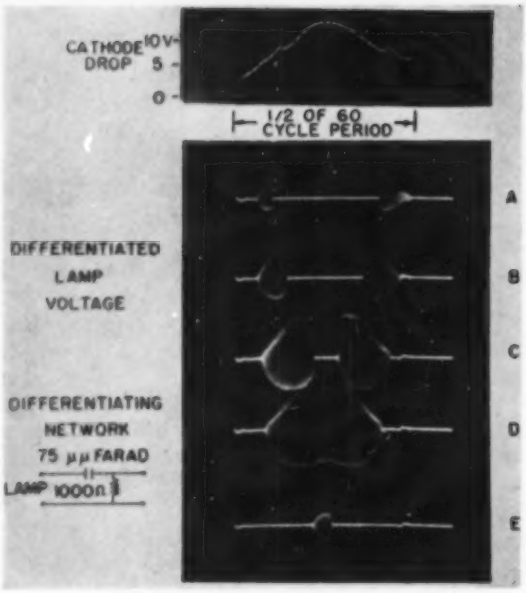

Figure 6. Characteristic of the fourth type of noise which leads to the designation twin noise.

quency in the lamp voltage trace is so small compared to the amplitude of 60-cycle variations that the oscilloscope amplifiers are quickly overloaded unless the low frequencies are filtered out. Actually, it is simpler to merely differentiate the total lamp voltage. Since differentiating $\sin\omega t$ yields $\omega\cos\omega t$ the components of a given frequency are weighted by the ω and only the high frequency components are observed on the oscilloscope. The differentiated anode oscillations are sharp spikes. The breakdown hash in the lamps used to obtain Fig. 2 was much smaller than these anode oscillation spikes. The breakdown noise in the lamps used to obtain Fig. 5 was comparable to the anode spikes, or about ½ a volt peak to peak.

Fig. 3 also indicates that above 2.4 megacycles there are peaks of noise generated during the latter part of one half cycle. This type of noise is caused by *extinction oscillations*. Whereas breakdown oscillations probably occur as the type of ionization changes as current increases, extinction oscillations probably occur at the time critical current is falling. They are not as frequent or as important as breakdown oscillations.

The differentiated voltage trace (or the noise meter trace) sometimes displays a fourth and last type of noise which will be called *twin noise*. The cathode drop varies with time as shown by the top trace in Fig. 6. A variation of the voltage between the filamentary cathode and a probe floating in the a-c discharge one-quarter inch away from the cathode (in the direction of the anode) is assumed to be a measure of the cathode drop. The potential at which a probe floats is less than the plasma potential at that point. Even if the probe were at plasma potential the contact voltages involved would produce an error. In spite of these errors the voltage between the cathode and probe does give a good indication of the cathode drop. The trace at the top of Fig. 6 shows the variation of this voltage for one-half cycle. The section above the zero line thus indicates the variation in cathode drop with time. Note that as the cathode drop rises, a critical value is reached at which it is suddenly reduced by about one volt. As this same critical value is reached during the falling part of the cycle, the cathode drop rises by this amount. If this signal is differentiated and amplified, a trace corresponding to *C* in Fig. 6 would be obtained. Practically the same result is obtained if the signal representing total lamp voltage is differentiated, except that small spikes representing the differentiated anode oscillations would appear.

The envelopes shown in this series represent high frequency oscillations of two or three volts maximum amplitude. A remarkable thing about these high frequency oscillations is revealed if they are spread out on the time scale. They repeat perfectly each half cycle, just as the breakdown oscillations do in some cases. The high frequency oscillations associated with twins have more than one periodicity, suggesting they are a result of the mising of several sinusoidal signals. As the discharge current is increased or as external heating of the cathodes is applied the cathode drop decreases slightly and the envelopes move closer together in time as illustrated by the series in Fig. 6 (going from *A* to *E*). This behavior of the envelopes (or the breaks in the cathode drop trace) prompted the designation twin noise. In trace *E* the cathode heating has progressed to the point where the twin envelopes have merged and almost disappeared. The twins have a big effect in the broadcast band as evidenced by the single peak spectrum given in Fig. 5. When the twins were not present the peak spectrum of this same lamp fell within the deviation shown for lamps exhibiting high amplitude breakdown oscillations. Thus the temperature of the filaments heated by a rapid start ballast can have a good or a bad effect on twin noise. Fortunately, this type of noise is not as common as other types; however its great magnitude when it does occur probably makes it the offender in lamps which are singled out as causing trouble.

Effect of Ballast in the Production of Breakdown Oscillations

A normal lead-lag ballast for glow switch starting was used to get the low noise spectra of Fig. 2. An instant-start ballast was used to get the high noise spectra of Fig. 5. As mentioned earlier, either ballast can produce either type of spectra depending on which oscillation types are evident in its lamp voltage trace. The previous history of the lamp influences these oscillations and the type of start given by the ballast is important. All five spectra for rapid start 40-watt lamps on a rapid start ballast fell between the two types. They had much smaller maxima occurring anywhere from 0.2 to 0.5 megacycles. Standard 40-watt lamps with only low amplitude oscillations evident on the lamp voltage trace, operated on a single lamp ballast and on a resistance ballast also gave spectra comparable to the rapid start data, that is, just a factor of three above the peak line of Fig. 2.

It was determined that the internal capacitors in the instant-start ballast reduced the noise only by about 2 to 1, a factor small compared to the variations noted here but important in critical cases. External capacitance of .003, .006, and .03 microfarad had about the same effect on breakdown oscillations but a much larger effect on twin noise. These figures are for noise radiated from the discharge.

Effect of the Inert Gas

The standard lamps referred to previously contained mercury vapor and a 3.2 millimeter pressure of argon. They all had spectra near or above the mean peak spectrum of Fig. 2. Methods of producing lamps having peak spectra below this line will now be considered. Fig. 7 gives the peak spectra for five neon-mercury and five xenon-mercury lamps each of which had an inert gas pressure of 2 millimeters. These were the only lamps tested and all had no high amplitude, high frequency oscillations in the lamp voltage trace and thus can be compared with peak spectra of Fig. 2, represented here as a straight line. Spectra for lamps containing a 2-millimeter pressure of argon or krypton with mercury fell between the two families shown in Fig. 7. Although there was little difference in the argon and krypton families it could be said that the mean spectra is lower the less the atomic weight of the inert gas. Thus, mean spectra have also been obtained for argon-mercury lamps at both 2 and 3.2 millimeters pressure. In addition, mean spectra have been obtained at 3.6 and 8 millimeters. Within the entire pressure range the noise increases with increasing argon pressure.

The xenon-mercury lamps consistently have only one cycle of the anode phenomenon per half cycle of the power frequency. A pulse of noise is produced at the end of the high voltage portion of the anode oscillation cycle, when the ionization occurs. For frequencies below 0.25 megacycles this pulse rivals the pulse of noise occurring at the beginning of each half cycle of the power frequency. In the broadcast band the great difference in the noise from the two types of lamps, the 30:1 ratio shown in Fig. 7, is caused by the greater breakdown noise peaks at the beginning of each half cycle. The breakdown peak in neon-mercury lamps is low enough to be rivaled by anode oscillations even in the broadcast band. These facts were ascertained from noise meter traces taken in the same manner as those of Fig. 3.

Effect of Changing the Cathode Design

The noise radiated can be reduced by using neon as a fill gas in place of argon or by using a lower argon pressure. Neither of these methods is considered commercially practical because the lamps would be short lived and the lamp voltage would be changed. The next question to be examined is whether changes in the cathode can reduce noise without changing lamp

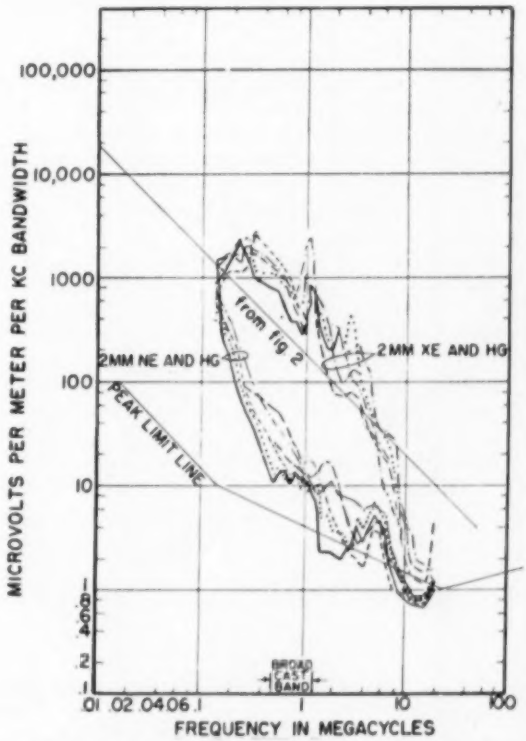

Figure 7. Peak noise radiated from a 40-watt lamp containing 2 mm xenon and mercury (upper family) and 2 mm neon and mercury (lower family).

voltage. Studies using standard coiled-coil filaments containing the primary mandrel indicate that reduction can be accomplished. The filaments used were made from 3-mil tungsten wire which is first wound on a 7-mil molybdenum mandrel to form the primary turns, and then both are wound around a 14-mil secondary mandrel which is then removed. The primary mandrel is usually dissolved out with an acid solvent. If the primary mandrel is left within the primary much higher currents are necessary to heat the filament to the temperature required to activate the carbonates. Standard mounts, however, can handle this current. The starting voltage surge of an instant-start ballast is sufficient to start the lamps with these mandrel filaments. These lamps operate at the normal operating voltage of standard 40-watt lamps; namely at about 102 volts.

It was found that lamps with filaments from which the primary mandrel had not been removed had noise spectra which steadily reduced with running although those of a standard lamp do not. See the change in spectrum with life of mandrel lamps in Fig. 8. Nine such mandrel lamps have now been tested and all showed this reduction of noise with life although the noise spectra do not always reach as low a position as the one indicated in Fig. 8. After 300 to 500 hours, this type of lamp is apt to develop twin noise and become more noisy than the spectrum given for zero hours. These "life tests" were made without the standard on-off cycling procedure. The standard lamp from among those used for Fig. 2 was given the same type of life test and showed no appreciable reduction in spectrum up to 2000 hours.

It still is possible that the mandrel lamp "life tests" are merely accelerated life tests in which the emission material disappears more rapidly due to a cooler hot spot. Attempts to determine why the mandrel lamps are quieter have failed to be conclusive. The breakdown peak observed with the noise meter output on an oscilloscope is reduced as a result, apparently, of a change in the character of the oscillations in the lamp voltage at breakdown. The most interesting tests are those with 15-mil rectagon filaments. A low noise low voltage lamp was obtained with this heavy filament indicating it is the heavy wire rather than a change in overall geometry that is important.

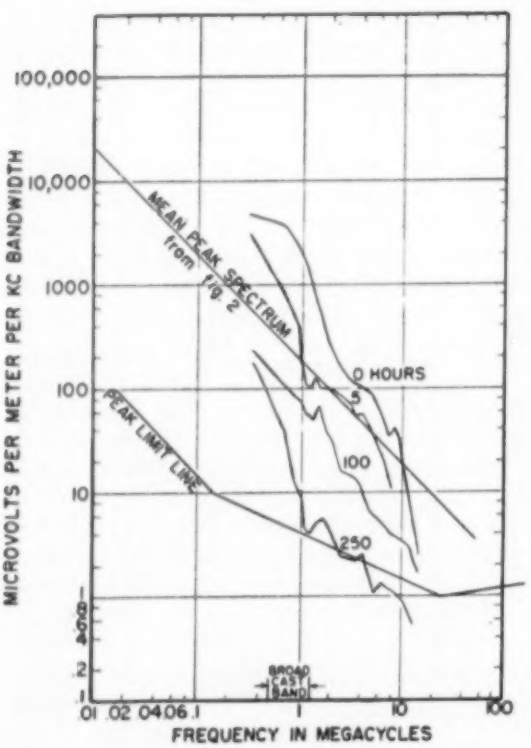

Figure 8. Peak noise radiated as a function of life from standard 40-watt lamps containing mandrels in the coiled coil filaments.

Conclusions

Several experimental methods of reducing radio noise below that ordinarily radiated have been presented for the purpose of understanding the characteristics of this noise. It is hoped that this study may eventually lead to an understanding of how the noise is generated and so that it can be reduced to a level satisfactory even in the most difficult type of installations. The noise was classified into four rather broad types. It appears that breakdown noise was usually the most important in the broadcast band. It was demonstrated that very low noise can be obtained without changing the lamp voltage or efficiency but that the life of these lamps at present is very short.

Acknowledgment

The author is indebted to M. R. Harnack and P. J. Walsh of this laboratory for their assistance in taking the data and to P. J. Walsh and W. E. Pakala of Westinghouse Electric Corp., East Pittsburgh, for many helpful discussions on technical matters.

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1. R. B. Schuls, Tele-Tech and Electronic Industries (Feb. 1954).
2. Government Specification JAN-I-225, 16E4 (Ships), MIL-I-16910 and MIL-I-6181.
3. Unpublished Draft of Proposed Standards (Sept. 22, 1953).
4. G. D. Lippert, W. E. Pakala, S. C. Bartlett, and C. D. Fahrnkopf, A.I.E.E. *Trans.* 70, 251 (1951) Table I.
5. See Table I of Reference (2).
6. See Discussion of Reference (3) by C. W. Frick, 9th Paragraph.
7. H. L. Steele, ILLUMINATING ENGINEERING, Vol. XLVII, p. 25A (October 1952).
8. See Canadian Patent 496,710 by E. G. F. Arnott (issued 1953); U. S. Patent on this is allowed but not issued, Serial No. 2405 (Filed January 15, 1948).

INSTALLATION IN RESIDENCE OF VERRALL MOE, FORT ATKINSON, WISCONSIN.

Lighting for a Built-In Sofa

LIGHTING OBJECTIVE: To provide local reading light for a built-in sofa as well as general lighting.

GENERAL INFORMATION: This is a country home in a woodland setting. The living room, a corner of which is illustrated above, is planned for family living and the entertainment of guests. The wall behind the bookshelves is covered by air maps, the background of which is pale green (45% RF). The ceiling is warm ivory-beige (62% RF) and the upper wall a darker tint of the same color (45% RF). The fireplace is of grey-white fieldstone.

INSTALLATION: A canopy open at top and bottom was built over the sofa to fit the need for both local and general lighting. In it are two lines of tandem strip fluorescent channels equipped with deluxe warm white lamps. There are two 40-watt and one 20-watt lamp in each continuous strip (40-watt on each end, 20-watt in center). Beyond the sofa this canopy narrows to a single line of lamps which continues beneath the clerestory window to the opposite end of the room.

The line drawing shows the construction and dimensions of this canopy, the top front edge of which is 27 inches from the slanted ceiling; the bottom of the canopy is 72 inches above the sofa seat. The frame is of redwood and the louvers of injection molded white plastic.

The illumination on a book held by a person seated on the sofa measures 20 footcandles. Brightnesses of the louvers, walls and ceiling, taken from the position of a seated person facing the sofa are as follows:

Bookcase wall, just above canopy	208 ft-L
Ceiling, above center of canopy	375 ft-L
Bottom of louvers	580 ft-L

For greater illumination level and uniformity of louver brightness four lines of fluorescent lamps instead of two could be used effectively.

Architect: William Kaiser, Madison, Wisconsin; fluorescent channel manufactured by Moe Light, Fort Atkinson, Wisconsin.

Lighting data submitted by Moe Light Division of Thomas Industries, Fort Atkinson, Wisconsin as one solution of a lighting problem and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

7-54

A.I.A. File No. 31-f

Graphical Determination Of Room Indexes

By RANDALL H. RICE

DOUBLE and triple interpolation of figures when determining room indexes sometimes lead to errors and is always a tedious job. Standard methods make use of room index tables, such as Table 1-9 of the *I.E.S. Lighting Handbook*, second edition. To eliminate this inconvenience and potential error source, a room index chart has been devised. This chart provides an accurate, rapid, and convenient determination of indexes. It is accurate within a fraction of a foot in all directions, and the determining procedure is so simple that it virtually precludes error.

Although the determination of this chart was done independently, it is interesting to note that the first phase of the chart is similar to a previous work by Mr. Willard Allphin,[1] and covers the relationship of room widths and room lengths. The second phase, however, relates the width-length relationship with a mounting or ceiling height factor (as required) and plots this total relationship directly on a superimposed plot of A-through-J Room Indexes. The room index plot is, of course, merely the boundary line plot of numerical room ratios obtained by the formulas on page 9-2 of *I.E.S. Lighting Handbook*, second edition. Room Ratios are also indicated on the chart.

Instructions are given on the chart and a sample solution is indicated by a dot-dash line. The chart covers most room sizes encountered in everyday practice but an additional note provides the Room Ratio formulas to cover the larger sized rooms. Note that a horizontal workplane 30 inches above the floor was assumed.

The first phase in the construction of the chart was to plot lines of equal room indexes (boundary room-ratio lines) using the minimum mounting height of seven feet for direct distribution and corrected to allow for a 30-inch workplane height. These lines are similar to lines of equal area but are modified by the definitive formula where

$$\text{Room Ratio (Direct)} = \frac{\text{Width} \times \text{Length}}{(\text{Mounting height above workplane}) \times (\text{width} + \text{length})}$$

By holding the mounting heights constant, equal Room Ratio lines were plotted on the Width and Length chart grid. It is obvious that these lines are symmetrical about a 45-degree axis so only the right hand portion of the chart is required. The 45-degree axis line, of course, represents a square room.

The second phase was to adapt the chart to plot extensions of these room index lines at different mounting or ceiling heights. Looking at the basic formula

$$RR = \frac{W\,L}{H\,(W + L)}$$

it is realized that the factor $\frac{W\,L}{W + L}$ is a constant for any particular room index line. And also, when plotted on the 45-degree axis (square room), $W = L = X$, where X equals a side dimension of the square room.

Therefore, $\frac{X^2}{2X} = \frac{X}{2} = k_j$ or k_i, etc.

The formula now becomes: $R = \frac{1}{H} \times k_j$.

Knowing k from the square room figures (45-degree axis intersection) room index lines for different mounting heights can be plotted.

The net result is a plot of "bands" of room indexes graphically portrayed in relation to width, length, and height.

It is suggested that the Society consider this chart as a replacement for the present standard tables for Room Indexes as it offers the following advantages:

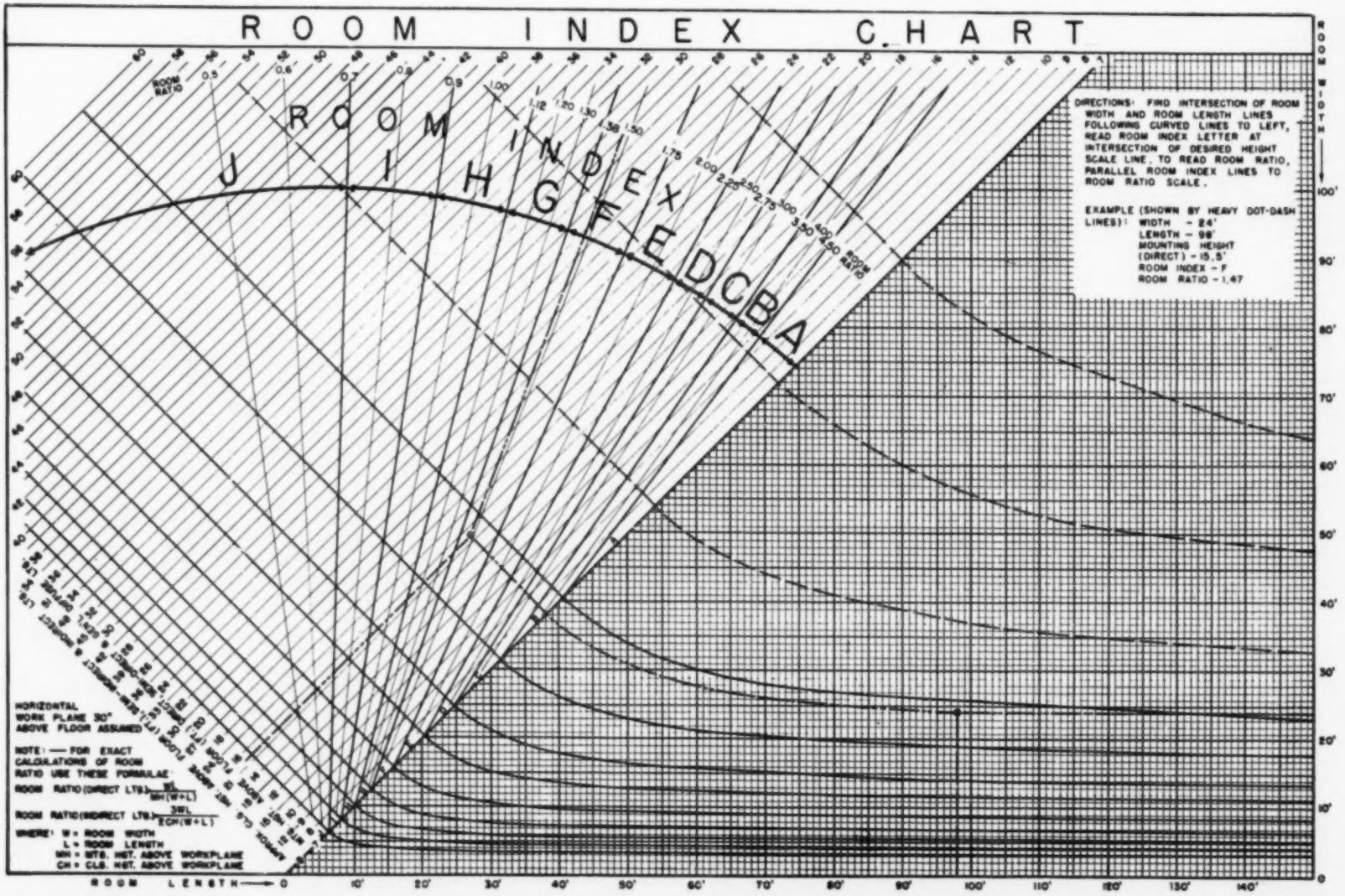
(1) Extremely accurate determinations of Room Indexes. The chart reads within a fraction of a foot in all three dimensions and the room index letter is positively determined.

(2) Room Index calculations are simplified as all double and triple interpolations are eliminated.

(3) The graphical method makes for faster calculating with less chance of error.

AUTHOR: Lighting Application Engineer, Westinghouse Electric Corp., Albany, N. Y.

1. Allphin, Willard: "Numerical Room Ratios," ILLUMINATING ENGINEERING, Vol. XLVIII, page 206 (April 1953).


ROOM INDEX CHART
ROOM INDEX
J I H G F E D C B A
ROOM RATIO
0.5
0.6
0.7
0.8
0.9
1.00
1.12
1.20
1.30
1.38
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.50
4.00
4.50
5.00
ROOM RATIO
DIRECTIONS: FIND INTERSECTION OF ROOM WIDTH AND ROOM LENGTH LINES FOLLOWING CURVED LINES TO LEFT, READ ROOM INDEX LETTER AT INTERSECTION OF DESIRED HEIGHT SCALE LINE. TO READ ROOM RATIO, PARALLEL ROOM INDEX LINES TO ROOM RATIO SCALE.
EXAMPLE (SHOWN BY HEAVY DOT-DASH LINES): WIDTH - 24'
LENGTH - 98'
MOUNTING HEIGHT (DIRECT) - 15.5'
ROOM INDEX - F
ROOM RATIO - 1.47
HORIZONTAL WORK PLANE 30" ABOVE FLOOR ASSUMED
NOTE: — FOR EXACT CALCULATIONS OF ROOM RATIO USE THESE FORMULAE
ROOM RATIO (DIRECT LTG.) $\frac{5WL}{MH(W+L)}$
ROOM RATIO (INDIRECT LTG.) $\frac{3WL}{CH(W+L)}$
WHERE: W = ROOM WIDTH
L = ROOM LENGTH
MH = MTG. HGT. ABOVE WORKPLANE
CH = CLG. HGT. ABOVE WORKPLANE
ROOM WIDTH
0'
10'
20'
30'
40'
50'
60'
70'
80'
90'
100'
ROOM LENGTH
0
10'
20'
30'
40'
50'
60'
70'
80'
90'
100'
110'
120'
130'
140'

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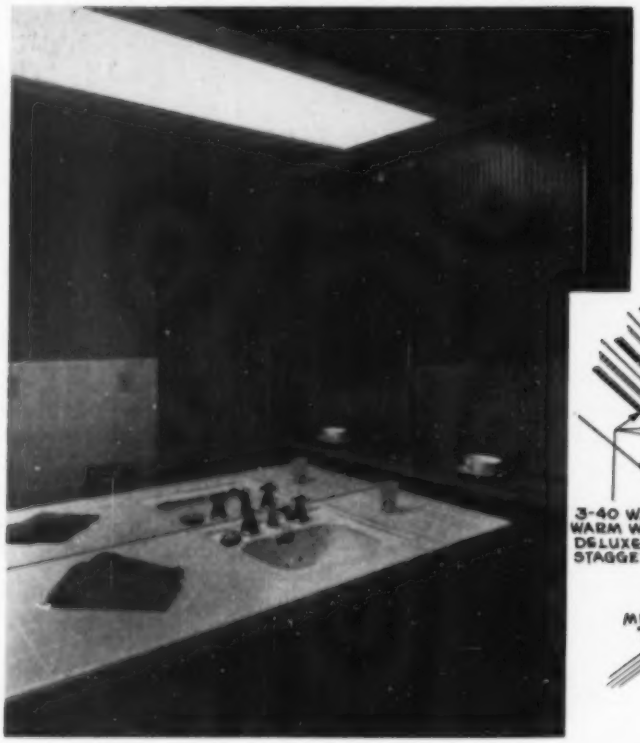
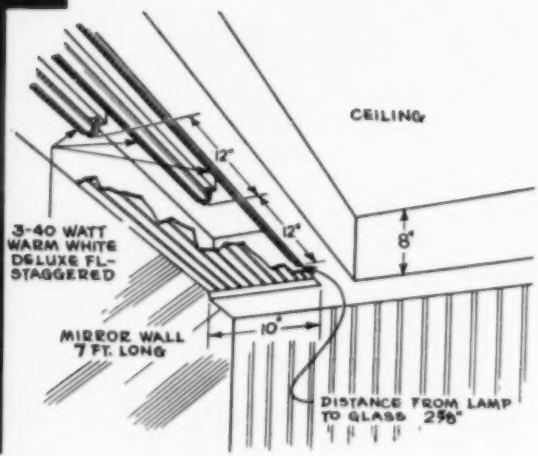


INSTALLATION AT
COLUMBUS, OHIO.



Lighting a Lavatory and Vanity Counter

LIGHTING OBJECTIVE: To provide 40 footcandles or more at a long mirror and counter serving as a combination shaving mirror and dressing table.

GENERAL INFORMATION: This bathroom is approximately 11 x 7 feet with an 8-foot ceiling. A plate glass mirror extends the full length of the 7-foot yellow ceramic tile (75% RF) lavatory-counter. The same yellow tile is used on the lower walls; the upper walls are covered with a 50% RF gray-background figured paper.

INSTALLATION: In a plaster soffit dropped 8 inches from the ceiling along the mirror wall are recessed three 40-watt deluxe warm white fluorescent lamps. The bottom of the soffit is covered by a 10-inch by 6 foot 9 inch frosted glass panel which rests on the top edge of the mirror and three sides of the soffit framework.

The three fluorescent lamps are on 3¼-inch centers, staggered (see sketch) so that they cover the entire length of the soffit and overlap in a two-foot section in the center. Distance from bottom of lamps to glass panel is 2⅝ inches.

Illumination measurements taken at standing position in the center of the mirror were: on center of cheek, 60 footcandles; on forehead, 70 footcandles; under chin, 20 footcandles. Brightness of soffit when viewed from standing position facing mirror averages 600 footlamberts at the center where the three tubes overlap and 240 footlamberts 6 inches in from the ends of the soffit.

Construction by: E. J. Cahill Builders, Inc., 420 South Powell Avenue, Columbus, Ohio.

Lighting data submitted by Blanche Waggener, Columbus & Southern Ohio Electric Company, Columbus, Ohio as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

7-54

A.I.A. File No. 31

Questions and Answers on light sources

The I.E.S. Committee on Light Sources, under the chairmanship of H. F. Davidson, has prepared this discussion to answer a question on the use of phosphors to improve the color of mercury lamps. Readers are invited by the Committee to submit other questions of general interest on light sources to be considered for publication. Questions may be sent in care of the Society headquarters office.

Improvement of Color of Mercury Lamps with Phosphors

Mercury lamps produce a distinctive greenish white light which is acceptable for many lighting applications but not satisfactory when color discrimination is involved. Due to the absence of red radiation in the arc, blue, green and yellow colors are accentuated while orange and red appear brownish. For this reason improvement of the color of mercury lamps is highly desirable for certain applications and has been achieved principally by the use of phosphor powders in combination with the quartz mercury arc type lamps. These lamps have a quartz inner arc tube and an outer jacket of glass. The inner arc tube generates large quantities of ultraviolet energy which is utilized by coating the inner surface of the outer glass bulb with a phosphor powder. The phosphor layer absorbs the invisible ultraviolet energy and transforms it into useful visible light having most of its energy in the red region where the mercury lamp is deficient (see Fig. 1). The combination of this radiation with the visible light produced by the mercury arc results in a golden white light in which most colored objects appear normal.

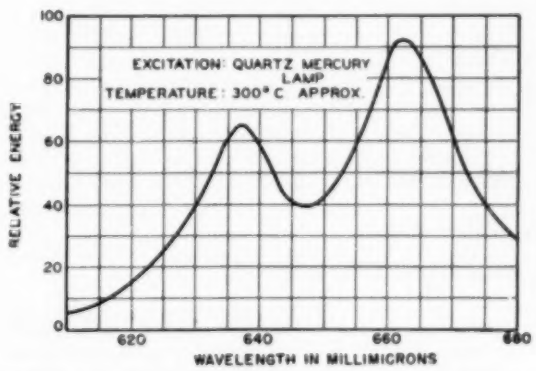


Figure 1. Spectral distribution of the luminescence of magnesium fluorogermanate.

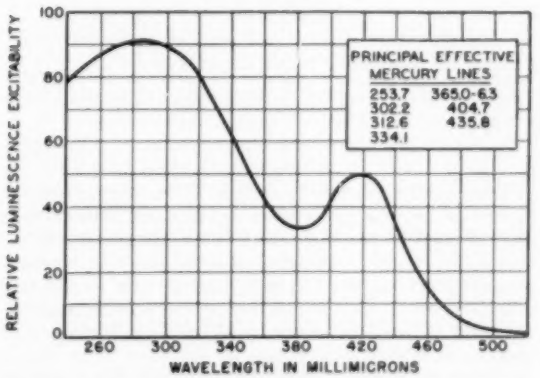


Figure 2. Excitation spectrum of magnesium fluorogermanate.

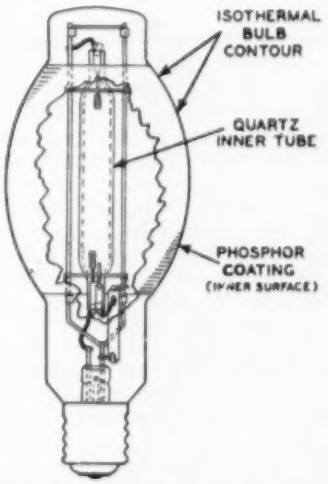


Figure 3. J-H1 type mercury lamp, color-improved.

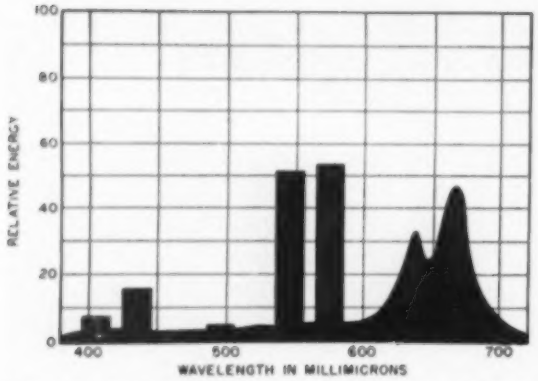


Figure 4. Spectral distribution of energy of the 400-watt J-H1 fluorescent mercury vapor lamp.

Several types of phosphors have been developed for this application and have proven well suited for use with quartz mercury lamps. These phosphors are very efficient at the high temperatures found on the outer bulb of mercury lamps and are very effective in the utilization of the available ultraviolet energy, particularly in the shorter wavelengths produced by the quartz mercury arc (Fig. 2). Virtually the entire light output of the phosphors is in the spectral region of 600-700 millimicrons (Fig. 1), thus balancing the mercury spectrum.

A typical example of the color improved mercury lamp is the J-H1 type (Fig. 3). This lamp has the phosphor coated on the inside of the outer bulb which has been designed to provide an approximately uniform temperature over its entire surface. The energy radiated from this lamp in the region 600-700 millimicrons is about 10 to 12 per cent of the total visible radiation from the lamp (Fig. 4). This is approximately the same percentage of red energy that is present in daylight. The J-H1 has an initial lamp efficiency of 42.5-47.5 lumens per watt and is rated at 4000 to 6000 hours life. It is the same electrically as the 400-watt E-H1 mercury vapor lamp. Its principal characteristics are given in Table 8-34, *IES Lighting Handbook*, Second Edition.

School Lighting and Posture

Discussion of paper by Willard Allphin

(Published April 1954 issue of ILLUMINATING ENGINEERING)

DARRELL BOYD HARMON*: Willard Allphin, in his paper, "School Lighting and Posture," introduces his study by saying:

> "The obvious need for *light*** in order to *see*, and the close relationships between *eyes* and the *other parts of the body*, sometimes suggests there may be a connection between *illumination* and *posture*.[1] (Reference 1 in the Allphin paper is: Harmon, D. B.: 'Lighting and Child Development,' ILLUMINATING ENGINEERING, April 1945.)
>
> "If such a connection exists, it would seem most likely to be found in *writing*, since it is most frequently in this occupation that children bend and twist and bring their eyes close to their work. This study, therefore, was based upon writing."

Allphin's conclusions state:

> "The author has no wish to minimize the importance of high illumination levels, good brightness ratios and freedom from glare. These things must certainly give a psychological 'lift' which should result in better schooling, even if we cannot establish exact physiological correlations at the present state of knowledge.
>
> "As far as the subject of this paper is concerned, however, it can be concluded from observations of which the photographs represent a small but typical sample:
>
> "1. In general, there seems to be no connection between *illumination* and *posture*.
>
> "2. Specifically, school children do not adjust their posture to avoid or reduce daylight glare."

In view of the fact that Allphin cites only one reference in connection with his entire paper (Harmon: *op. cit.*) — a reference reaching a conclusion opposite to his — and also because of the apparent simplicity of method by which he reached his general conclusion that "there seems to be no connection between illumination and posture," a bibliography is needed for his study. Such a bibliography is imperative, if for no other reason than it would prevent the casual or uninformed reader of Allphin's paper (due to the "recency effect" of the date of publication of his paper as compared to the date (1945) of the one cited) from concluding:

(a), that the author of the single paper cited was careless, uninformed, or lacking in skill in making his study; and/or,

(b), that there are no existing studies, publications, or

*Consulting Educationist, Austin, Texas.

**Italics throughout this paper are the present author's. They are used in this first instance for a reference which follows. (See page 363.)

other data having a significant bearing on the subject of the study (as seems to be implied in Allphin's summation, quoted above).

I am certain that Allphin had none of these effects on his readers in mind when he used only a single citation, or he would have included a bibliography with his paper (in keeping with good scientific method) comparable to the one which follows.

Apart from the above, the extent of available references indicating conclusions contrary to Allphin's,† and the exceeding complexity of the area of investigation both point to the need for such a bibliography. The purpose of this discussion is to present a few references, germane to Allphin's topic of study, to compensate for his seemingly inadvertent omission. As the one cited in his paper, I have assumed the privilege of compiling these annotated references.

Our first references are concerned with some methods widely used in present day research, *i.e.*, dimensional analysis, and symbolic or mathematical logic. Methods from these two fields are extensively used by serious investigators working with complex, multi-variable problems to check the reasonableness of their assumptions and experimental design, and the validity of the reports of their studies.

1. Bridgman, P. W.: *Dimensional Analysis*, Yale University Press, 1931; or, other standard references on dimensional analysis; and,
2. Boole, George: *The Mathematical Analysis of Logic*, Philosophical Library, 1948 (a reprint of a work first published in 1847); or, other standard references on symbolic or mathematical logic.

When one applies some simple methods from these two fields to the stated or implied assumptions in the sentence quoted from the first paragraph of Allphin's paper (in the light of the implied assumptions in his general conclusion "1"), one arrives at some very interesting results.

For example, Allphin implies that *light*,* or *illumination* (L), acting upon *eyes* (E) produces *seeing* (S). Dimensionally this is equivalent to: $\frac{ML^2}{T^2}$ operating on [an equivalent to a transforming function]** to produce $\frac{ML^2}{T^2}$ — which for simplicity will be written here as: $(L \cdot E = S)$. His use in context of the term *posture* (P) implies that it, too, can be represented dimensionally by $\frac{ML^2}{T^2}$; and, similarly, his term *other parts of the body* (B) is also used so as to be: [an equivalent to a transforming function].** But, because he concludes that *light*, or, *illumination* (L) has no connection with, or does not produce *posture* (P), then, by implication, he is also saying that some unknown energy (U), which can be dimensionally represented by $\frac{ML^2}{T^2}$, is operating on (B) to produce (P). This, also for simplicity, will be written here as: $(U \cdot B = P)$.

Within the calculus of propositions $(L \cdot E = S)$ and $(U \cdot B = P)$ are two classes, and, within the limits set by Allphin's paper, they are the two classes he is considering. Also within the limits he sets, they have mutually exclusive terms. However, they do constitute the universe under scrutiny — which is permissible. A universe is always equal to 1, so all of this would then mean that:

$(L \cdot E = S)$ is his Class X, determined by the symbol x; and,

$(U \cdot B = P)$ is his Class Not X, determined by the symbol $1 - x$.

This apparently makes his proposition consistent or true, because:

$$x + (1 - x) = 1.$$

However, Allphin also says that there are "close relationships between the *eyes* and *other parts of the body*." The denoted meaning of the term "relationships" in this context is "connections" or "interact with." This, then, would call for another "determiner" in the equation demonstrating the validity of the proposition, which we can represent by the symbol v. Allphin indicates, as has been said, that he is considering only the two classes mentioned above, and v is concerned with a term in each of those classes. Without a V-class in his proposition, the only uses that can be made of v is to produce:

$$\text{either (1)}, \quad xv + v(1 - x) = 1$$
$$\text{or (2)} \quad v + (x + (1 - x)) = v + 1.$$

Equation (1) would lead to: $v = 1$, and this could not be true as the symbol 1 represents the universe. Such a situation would mean that either more than one universe or more than two classes were being dealt with, but not being recognized. This would indicate, among other things, that there was an error in his experimental design.

Equation (2) would be redundant — which could indicate faulty basic assumptions or conclusions in the study.

While we are on mathematical references, another should be included that deals with an element in the experimental design of any study having to do with light and posture. This reference is concerned with methods for analyzing the factors relevant to postures found in a given situation:

3. Hague, B.: *An Introduction to Vector Analysis*, John Wiley and Sons, Inc., 1951; or, other standard references on vector and tensor analysis.

Functional posture and its determinants can be studied only by stress-strain analysis, or some method derived from such analysis.* This involves more than observations of an apparent horizontal rotation of the head or trunk — the method that Allphin seems to have used in his study.

When a child is standing or seated in a balanced position, facing forward, and *with no task to perform*, visually-centered or otherwise, his head and trunk can be considered an essentially isotropic medium,** as far as any head or trunk rotations are concerned. This is due to the fact that, in this position, the child's body co-ordinates and the gravitational co-ordinates affecting him are, for practical purposes, coincidental. In such a situation, for any stimulus causing a head rotation, the turning of the head and body will be a fairly smooth function of the trunk, neck, and head, above some point in the body. In other words, the strain (rotation), (X), can be related to the stress (stimulus), (S), by a simple vector equation: "stress equals a proportionality coefficient times strain, with stress and strain as vectors" — *i.e.*, $\overline{S} = k\overline{X}$.

†Including a very recent one: Logan, H. L., "The Orientation Reflex," Illuminating Engineering, Vol. XLIX, No. 1 (1954), which was presented at the New York National Technical Conference of I.E.S., September 1953.

*The italicized words are the same as those italicized in Allphin's statements quoted above, and have been so marked for ready cross reference.

**There is no ready standard symbol for this function, so the phrase is used here in brackets as if it was a symbol.

*Such a derived method was used in the Harmon reference which Allphin cites.

**Within the limits of movement of the system.

In the situations similar to the above, if the lighting was so unbalanced as to interfere with adaptation, or, with resolution of a casual forward task involving only recognition (and if light did affect posture), then, the child could be expected to rotate his head, or head and trunk, horizontally and away from the interfering light.

The above method of analysis, however, does not hold true for a child working at a sustained visually-centered task such as writing — the task selected by Allphin for his posture observations.

In a sustained visually-centered task, a line of sight is established between the eyes, or inter-pupillary point) and a point immediate to the task, and this line of sight becomes an invariant property of the system. This means that the axis established by the line of sight remains as long as the task continues, no matter what outside force may enter and attempt to transform the situation. In addition, the vertical gravitational axis is still an invariant of the system. With at least these two axes† of the system about which movements must take place in relation to outside stimuli or events, the trunk and head can no longer be considered an isotropic system with respect to rotations, and any relation between stress and strain then could only be determined by a tensor operation.

With two or more axes as invariants in the system, the relation between the stress induced (*e.g.*, glare) and the strain (body movements in this case, since there could be rotations of various segments of the body, together with non-rotational movements) is not a simple vector equation.

Instead, the invariant axes are related by a transforming function which demands that body movements be such as to keep the two or more invariants of the system within the possible positions of the system. In other words, simple rotation of the head and trunk can no longer take place in response to a stimulus, but an essentially non-isotropic response is produced. This can include rotations of some of the segments of the body in planes which are not horizontal. The equation for relating stress to strain would now be at least: $S = \phi X$.

Such a condition could mean that, if light did affect posture, a child might be apparently rotating his head horizontally towards glaring windows, but still be making a forward, or a forward and oblique rotation of his head so as to minimize or eliminate the effect of the glare at the retina. A close inspection of the picture show that this is probably the case in respect to the children in Allphin's Figure 3, even though his interpretation is, as he says in his text:

> ". . . note the boys and girls in the upper center of Figure 3, who have the windows on their right. They are tilted and twisted so as to receive more daylight glare, not less."

Now let's turn to references concerned with the question, "Is there, or could there be connections between body posture and illumination?"* The study of the relation of light and posture (or of light, vision, and posture) is not a new field,** although it may seem new to the lighting engineering profession. The earliest publication of which I have information which refers to studies on a possible relation between light and posture in school children as a cause of visual difficulties is one by E. Meyer in 1869 (Meyer, E.: *A Practical Treatise on Diseases of the Eye*, Paris, 1869, Berlin, 1875). Another ophthalmologist published a study in 1891 (*The Optician*, I, 1, 1891) in which he concluded that the postural effects of school lighting, seating, and flat tables entered into the etiology of myopia in school children.

It must be conceded that early investigators did not have at their disposal the sound instruments, the large body of knowledge, and the valid techniques which modern science has furnished, so their conclusions cannot be taken too seriously except to indicate a trend. However, numerous reputable investigators* who are using the facilities and methods of modern research, have from time to time in recent years published reports of their studies which have included neurological, behavioral, symptomatic, and other forms of data which do relate light to posture or light and vision to posture. I am personally familiar with several hundred such references — contained in books and other publications which I can see as I glance around at the bookshelves which surround me in my office. They cover a multitude of topics of investigation — but all showing some type of positive light-posture relationship — ranging from:

4. Wells, H. S.: *The Demonstration of Tonic Neck and Labyrinthine Reflexes and Positive Heliotropic Responses in Normal Human Subjects*, Science 99, (1944) pp. 36-37;

which shows the existence of a number of light instigated postural responses in normal human adults, on to a study on:

5. Finneran, Lillie Mae: *Relation of Certain Biochemical Factors of Writing Activity to Visual Performance and Occlusion* (dental), M. A. Thesis, University of Texas, August 1945;

which demonstrates a significant positive relationship between posture induced by classroom conditions and visual and dental difficulties in high school children.

Twelve of the references which I possess, containing information or data on various factors indicating the existence of a positive relationship between light and posture, are within easy reach of my desk as I write this page. They will suffice for our purposes here in providing a basic bibliography for Allphin's paper, as all of them should be readily available to illuminating engineers.

The first of these references is a standard, comprehensive, and widely used work on medical physiology:

6. Best, Charles Herbert, and Taylor, Norman Burke: *The Physiological Basis of Medical Practice*, Fourth Edition, The Williams and Wilkins Company, 1945.

On page 1009 of this work, Best and Taylor say:

> "The optic tract passes backward and outwards between the tuber cinereum and the anterior perforated substance to the cerebral peduncle around which it turns as a flattened band to reach the external (lateral) geniculate body. In this, the primary visual center, the great majority of the optic fibers end. A smaller number are continued to the superior colliculus (superior

†In writing, the task demands on the arm and hand, together with the postural demands for counter-balancing arm and hand movements in the task, can set up additional axes which also become invariants of the system. Similarly, postural requirements of seats, desks, etc., can also make their demands as system invariants.

*At a conference of vision research specialists held at Nela Park, April 19-21, 1954, Dr. Warren S. McCulloch, Neurophysiologist, Laboratory of Electronics, Massachusetts Institute of Technology, presented a paper demonstrating the major nervous areas through which such connections operate.

**Nor was it invented by me, as Allphin's single reference might imply.

*Investigators representing a number of different fields concerned with human performance; such as Warren S. McCulloch, Neurophysiologist, of the Massachusetts Institute of Technology, and Samuel Renshaw, Experimental Psychologist, of Ohio State University, who both have published a number of papers in their respective fields which have included evidence demonstrating the existence of various factors relating light to posture in the mechanisms of human behavior.

corpus quadrigeminum) but none of these are macular in origin. *The superior colliculus serves as a center for light reflexes and the correlation of impulses from the retina with movements of the skeletal (posturing) muscles,* but apparently not for sight."

The second reference is an equally comprehensive, widely used, standard work on ophthalmology:

7. DUKE-ELDER, SIR W. STEWART: *Text-Book of Ophthalmology*, Vol. I, "The Development, Form, and Function of the Visual Apparatus" — (Second Impression, With Corrections and Additions), 1942, C. V. Mosby Company.

In this work Duke-Elder presents a more elaborate development of the subject quoted above of Best and Taylor:

(Page 242) "When vertebrates appeared . . . the visual impulses were primarily photostatic (light-balancing) and were conducted to the roof of the mid-brain which provided an automatic mechanism for promoting appropriate posture movements. . . . The most salient factor in the evolution of man was the ousting of smell as the dominant sense and its replacement by vision (Elliot Smith, 1927); and to equip the eyes with the power to form the basis of man's physical dexterity and intellectual supremacy the whole central nervous system has been reorganized. . . . (However), *when the neopallium (high brain centers) appeared the mid-brain certainly retained its photostatic functions; . . .*"

(Pages 247-248) "The fibres from the retina end in two masses of grey matter: the LATERAL GENICULATE BODY, which is phylogenetically part of the optic thalamus, and the SUPERIOR COLLICULUS, which is part of the *mid-brain*. . . . The visual fibres (in man) find a (relay) station in the lateral geniculate body. . . . 80% of the retinal fibres find their way here. . . . *The (retinal) fibres which run to (the superior colliculus), however, are undoubtedly the most primitive phylogenetically . . . , and in man they are associated with the primitive photostatic (light and posture) rather than the higher sensory functions of vision.*"

(Page 250) "The posterior extremity of the optic thalamus is especially intimately connected with the angular gyrus, the praecuneus, and the occipito-parietal and occipito-temporal lobes, and therefore, when its intimate relation with the cerebellum (Horsley and Clarke, 1905) and the red nucleus (Sachs, 1909) is remembered, it seems probable that *it is largely concerned with the movements of the eyes, the correlation of eyes and hands, and the higher visual functions of stereognosis.*"*

Elaborations of the neurological and other mechanisms of light-posture relations can be found in:

8. GRAY, HENRY: *Anatomy of the Human Body*, Lea and Febiger, 1924, pp. 876-877, etc.;
9. MAGNUS, R.: *Körperstellung*, Julius Springer, Berlin, 1924; Especially chapters 2 through 7;
10. HERRICK, C. JUDSON: *An Introduction to Neurology*, W. B. Saunders Company, 1931, p. 254, first paragraph.

Other fields than ophthalmology, physiology, anatomy, and neurology have also contributed to demonstrating that a light-postural relationship exists:

11. KLÜVER, HEINRICH: Editor, *Visual Mechanisms*, Biological Symposia, Vol. VII. Jacques Cattell Press, 1942: LASHLEY, K. S.: "The Problem of Cerebral Organization in Vision," page 301 ff.

The data Lashley presents in this paper leads him to conclude:

"The visual system is primarily concerned with spatial orientation and for its transition from a sensory to a motor pattern can be most adequately conceived as an interplay of polarized systems or of interweaving dynamic patterns in which the spatial properties of the visual stimulus are translated by integration at a series of levels into modifications of the general pattern of postural organization."

12. VERNON, M. D.: *A Further Study of Visual Perception*, Cambridge University Press, 1952, p. 91.
"From this discussion, it appears that our normal accurate sense of spatial orientation and our accuracy of movement are dependent upon the maintenance of the habitual relationship of the main co-ordinates of the visually perceived field with both kinaesthetic and labyrinthine sensations (the latter producing together the vertical gravitational sense). . . . The individual's feeling of stability depends upon the stability of this framework. If some part of the sensory data which constitute the framework is impaired, or conflicts with some other part, stability is so far affected that the individual is disoriented, that is to say, he loses his usual impression of an exact and enduring position of his body in space."
13. JEFFRESS, LLOYD A.: Editor, *Cerebral Mechanisms in Behavior*, The Hixon Symposium, John Wiley and Sons, Inc., 1951:
MCCULLOCH, WARREN S.: "Why the Mind is in the Head," pages 42-56 (particularly page 48);
LASHLEY, K. S.: "The Problem of Serial Order in Behavior," pages 112-135 (particularly pages 124-127 on "Space Coordinate Systems").

Two additional references would also be applicable, if read in the light of the above references 5 to 13:

14. HALSTEAD, WARD C.: *Brain and Intelligence*, University of Chicago Press, 1947, Chapters IX and X; and,
15. BARTLEY, S. HOWARD, and CHUTE, ELOISE: *Fatigue and Impairment in Man*, McGraw-Hill Book Company, Inc., 1947, pp. 173-174.

One very recent neurological investigation, specifically indicating some of the posturing musculature activated by unbalanced lighting, completes our references having to do with the mechanisms of light's relationship to posture:

16. LUNDERVOLD, ARNE J. S.: *Electromyographic Investigations of Position and Manner of Working in Typewriting*, (From the Pharmacological Institute, University of Oslo, The Neurological Clinic, University of Oslo, and The Department of Human Anatomy, University Museum, Oxford), Acta Physiologica Scandinavica, Vol. 24, Supplementum 85, Oslo, 1951.
(Page 3) "Typists (were) selected for investigation because they form a large occupational group having a relatively uniform work which demands comparatively few movements, and these movements are well suited for electromyographic recording."
(Pages 164-165) "Eighteen women and twenty-nine men belonging to different age-groups and having varying degrees of practice in typewriting were subjected to electromyographic examination while writing on the machine. . . .
"When a single key of the typewriter was depressed with a certain degree of rapidity, action potentials were recorded from most of the muscles in the upper extremities and the back on the same side, and occasionally

*Which is most likely a derivative of central vision and postural functioning.

also from heterolateral muscles, and then especially the proximal muscles. . . .

"The number of muscles that took part in a particular movement, as well as the force of contraction in each muscle, was dependent upon different factors. The combined force of contraction usually increased under the following circumstances: 1 . . . 2 . . . 3 . . . 4 . . . 5, in the case of bad lighting."

(Page 142) "Similar tests were made in order to ascertain whether the illumination conditions had any influence on the electrical activity of the muscles during typewriting. . . .

"(When) the persons tested were called upon to write a balanced sentence or to do ordinary typewriting, we recorded in all the unpracticed writers considerably more action potentials when the exercises were done under bad lighting conditions. On the other hand, the degree of illumination seemed to have no influence on the electric activity of the muscles of the skilled typists when they were writing from dictation. If they wrote from manuscript (a visually-centered task), however, the electromuscular activity increased also in their case. . . . This increased muscular activity was *most pronounced in the dorsal muscles.*"*

(Page 134) "Since the consumption of energy in static muscular work is so disproportionally great compared with mechanical work (A. Kindstrand, Affarsekonomi, 1944, 1-27), it must be assumed that the contraction conditions in the dorsal muscles are of importance. . . . The more so because the muscles investigated belong to the most important *postural muscles.* . . . When such contraction takes place, for instance in forward bending position, the pulse rate, metabolism and blood pressure will be increased (E. Knowles, 1946.)."

In the course of his discussion about school children "bringing the eyes close to the work" Allphin raises the question, "Does it do any damage?" He answers the question by quoting an ophthalmologist as saying, "it seems unlikely that any harm is done by bringing the eyes close to the work. . . ." The data found by Finnegan in the study mentioned in our reference 5, above, demonstrates a contrary conclusion.

Finnegan, assisted by a physiologist, two optometrists, and an orthodontist, studied a group of high school children in Dallas, Texas. Her data showed a significantly increasing incidence in visual, postural, and dental difficulties in children which were forced to reduce the distance between their eyes and their work because of classroom conditions.

TABLE I.—Summary of Finnegan's Data.

Ratio between normal visual distance for task (individually determined), and the distance at which the children were habitually forced to work:	Percentage of difficulties in group with this distance ratio:		Percentage this group was of total group:
1.00	Visual	15%	10.5%
	Postural	0%	
	Dental	32%	
1.22	Visual	70%	30.5%
	Postural	15%	
	Dental	85%	
1.65	Visual	70%	42.0%
	Postural	28%	
	Dental	87%	
2.84	Visual	79%	17.5%
	Postural	49%	
	Dental	89%	

*Posturing muscles of the lower back.

A rough tabular summary of her data is given in Table I.

Allphin also says in his discussion, "It seems doubtful that such comparatively short portions of the day would produce permanent postural defects even among those who write in presumably strained positions." Again, a recently published study reveals data contrary to his conclusion:

17. KEPHART, NEWELL C., and FLOYD, WILLIAM: *Classroom Environment and Pupil Welfare,* Journal of Educational Psychology, 55, 1, 1954, pp. 52-59.

This study of fourth and fifth grade children in the Morton School, West Lafayette, Indiana, made by a professor of psychology at Purdue University and a superintendent of schools, was concerned with the effect on children of the physical surroundings (lighting, seating and decoration) in conventional classrooms, as compared to experimental classrooms duplicating the experimental surroundings used in the Harmon study cited by Allphin.

Their findings showed (using standardized techniques for determining postural deviation) that while 49 per cent of the fourth and fifth grade children in the control rooms showed postural deviation after one year in those rooms, only 27 per cent of the fourth and fifth grade children in the experimental rooms showed the postural problem related to their work which the study was checking. In other words, there were 45 per cent fewer postural deviations related to close visually-centered school work in the experimental situation. This difference is statistically significant, having a *t*-value of 2.18.

As I have mentioned above, there is at least a bibliography of several hundred references concerned with various aspects of the relation of light to posture, although it is not systematically organized into a compact body of literature, as is the visual data on recognition and central field seeing. There probably is a good reason for this lack of organization up to this time. Increasing pressures of the social situation for improved recognition in seeing tasks, has kept the ophthalmologist, the optometrist, and the illuminating engineer preoccupied with the morphological problems of the foveal portion of vision, and of the social task of efficient and rapid identification.

There has been no specialty, or field of practice concerned alone with light and posture, or with light, vision, and the efficient body mechanics of visually-centered tasks. The work that has been done, has been the work of those primarily interested in other affairs of human function, or human activity. Nevertheless, "light-vision-body mechanics" is an area significant to the illuminating engineer. With data on the central field aspects of seeing, as it relates to light, now reaching a point where it can be largely systematized into lighting standards for efficient recognition, the illuminating engineer should increase his concern with studies in this other area of lighting, which seems to be so closely related to human efficiency and productivity. It offers promise of revealing quantitative answers to many of the illumination problems of "performance efficiency," "visual fatigue," "comfort-discomfort" brightness characteristics, and many other stresses or strains of visually-centered work which correlate with lighting design.

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

I.E.S. Council Meets in New York
Summary of Action Taken

The last Council of the current administration was held in New York City June 10. Presiding was A. Homer Manwaring, President, with the following in attendance: Past Presidents S. G. Hibben and E. M. Strong; Vice-Presidents D. M. Jones and R. F. Hartenstein; General Secretary M. N. Waterman; Treasurer K. M. Reid; Directors, G. W. Beals, R. M. Zabel proxy for J. S. Schuchert, C. C. Shotwell, W. A. Stannard, F. C. Winkler; Regional Vice-Presidents C. J. Berry, M. B. Hastings, S. H. Hazleton proxy for L. A. Hobbs, H. L. Logan proxy for W. J. Lind, G. E. Park, C. W. McCormick proxy for G. J. Taylor, L. C. Twichell; Executive Secretary A. D. Hinckley; Technical Director C. L. Crouch; Editor Ruby Redford; Advertising and Promotion Manager C. E. Ellis; A. A. Brainerd, G. G. Rae, A. C. Sangster and D. L. Williams.

New Member Emeritus

On recommendation of the General Board of Examiners, Council approved the election of Dr. N. A. Halbertsma, of 's-Gravenhage, Holland, to Member Emeritus of I.E.S. Dr. Halbertsma, a former President of the International Commission of Illumination, is an internationally-known leader in the illuminating field. He has been a distinguished foreign member of this Society since 1919, with the exception of the occupation years 1940-45. His retirement from the N. V. Philips' Gloelampen Fabrieken, Eindhoven, Holland was announced recently.

The Board of Examiners also recommended the election of 20 Members, and reported their election of 86 Associate Members and 10 Students. Current membership, following Council action, was shown to be as follows:

September 30, 1953		June 10, 1954
7795	Total Membership	8358
32	Members Emeritus	34*
70	Fellows	68
1870	Members	1982
5579	Associate Members	5986
244	Student Members	288

*Includes 12 Fellows.

Technical Committees Report

Final reports from three I.E.S. technical committees were presented to Council. Reports of the Light Control and Equipment Design Committee presented by David L. Williams, Chairman, and of the Illumination Performance Recommendations Committee, presented by C. L. Crouch, were approved for letter ballot of Council members.

A proposed revision of the Recommended Practice of Office Lighting, submitted by J. J. Neidhart, Chairman of the Office Lighting Committee, was carefully discussed, in relation to reports expected soon from the Q and Q committee and the School Lighting Committee. F. W. Winkler represented Mr. Neidhart in the discussion. Pending qualifying statements to be added to the report, mutually acceptable to both School and Office Lighting Committees, the report was approved for letter ballot.

New Officers

The Tellers Report on the election of I.E.S. national and section officers for 1954-1955 was given by Marshall Waterman, General Secretary. A complete list of these elections is given elsewhere in this issue of the Telecast.

I.E.S. and Civil Defense

Three members of the Federal Authority for Civil Defense attended Council, and reported in person their program on lighting for civilian defense. Plans for this phase of the defense plans hinge on close cooperation with the I.E.S. Committee on Lighting for Civil Defense, and personal liaison with its chairman, J. C. Forbes. The I.E.S. committee will be the advisory body for Army plans in this connection, aiming at maximum effectiveness with minimum inconvenience to civilian operation in any future wartime lighting restrictions. Speaking for the Army and Defense Administration were: Colonel Barnet Beers, and Colonel J. T. Clark, U. S. Army, and Mr. Phillip Batson of the Federal Civil Defense Administration.

J. C. Forbes reported for the I.E.S. Committee to work on the preparation of a technical booklet for the guidance of the Federal Civil Defense Administration. Several specific committee appointments in this connection were approved.

Publications

In the absence of Publications Chairman, J. S. Schuchert, an interim report on the Society's publications program was given by Dr. R. M. Zabel, a member of the committee. Highlights included recommendations for an active local participation through Papers Reporters and Publication Sales Representatives, and on the priority review of M.M.I.L.J. contest entries. The committee also made recommendations for a general training program for all local chairmen, suggesting the appointment of a Standing Committee on Training.

The report indicated that the Society's publication program is being operated within its budget for both cost and income.

Three New Chapters

Charters were approved for three active groups, as follows:

Palmetto Chapter in Greenville, South Carolina. This group grew from a successful Study Club which petitioned for Chapter status through Regional Vice-President G. L. Parks.

Arkansas Chapter, Little Rock, Ark.

I.E.S. National Technical Conference
Hotel Chalfonte-Haddon Hall
Atlantic City, New Jersey
September 13-17, 1954

This group also acted for several years as a successful Study Club with full officer organization.

Miami Valley Chapter, Dayton, Ohio. Petition for charter was presented by L. C. Twichell, Regional V-P, for this group who have also been fully organized and operating for I.E.S. for some time.

R. F. Hartenstein, Chairman of the Regional Activities Committee reported recommendations made by the Regional V-P's at their meeting on June 9.

Other committee reports presented to Council included: Historical Committee, by S. G. Hibben, Chairman; Membership Committee submitted by Ted Lauer, Chairman; National Conference Committee reported by Marshall Waterman; Papers Committee by Dr. R. M. Zabel, Chairman.

Diversified Program Presented At Milwaukee Section Conference

Street and highway safety, industrial production and protection, public recreation, commercial building beauty and advertising—as they involve lighting—were topics covered at the sixth annual spring conference sponsored by the Milwaukee Section of I.E.S., May 21.

This varied program was as follows:

Outdoor Lighting for Industrial Production and Safety — Carl Jensen, Westinghouse Electric Corp., Chicago.
Exterior Building Lighting for Beauty and Utility—C. N. Laupp, Wisconsin Electric Power Co., Milwaukee.
How Much Light for Parking—Warren H. Edman, Holophane Co., Inc., New York City.
Public Recreation and Sports Lighting—H. F. Ilgner, Bureau of Electric Service, City of Milwaukee.
Light and Night Traffic Accidents—D. M. Baldwin, National Safety Council, Chicago.
Street and Highway Safety Lighting Panel —
W. B. Kennedy—Sylvania Electric Products Inc., Salem, Mass.
D. W. Rowten—Westinghouse Electric Corp., Clevaland.
R. F. VandenBoom—General Electric Co., Milwaukee.
Stacey Standley—Line Material Co., Milwaukee.
M. B. Grant—Union Metal Mfg. Co., Chicago.

Summary of Attendance at Chicago School Lighting Clinic

That the Chicago School Lighting Clinic, held March 25, reached the right audience is proved in a breakdown of attendance figures, released by the sponsors, the Chicago Lighting Institute and the Chicago Section of I.E.S. The total of 96, analyzed by profession, comes to:

Educators and School Administrators	36
Fixture Mfrs. and Allied Industries	20
Architects and Engineers	14
Light Source Manufacturers	7
Wholesalers and Manufacturers Reps.	5
Electric Utilities	8
Miscellaneous	6

I.E.S. members and their wives enjoyed an evening of dinner dancing in the Peacock Court of the Hotel Mark Hopkins at the President's Dinner.

South Pacific Regional Conference Features Public Jubilee Celebration

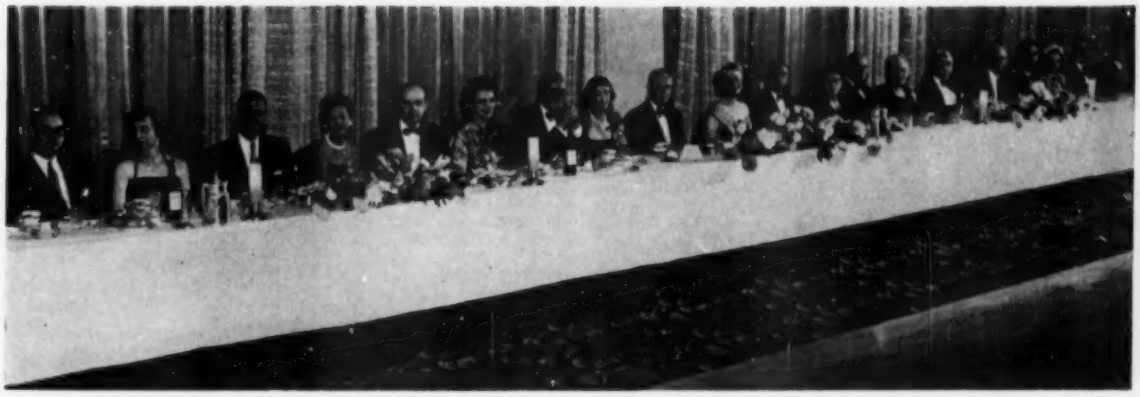
Reference has been made on many occasions to "West Coast I.E.S. Conventions," in reporting their Regional Conferences. The meeting held April 19 and 20 by the South Pacific Coast Region of I.E.S. went still further in this connection, benefiting two additional groups — the Museum of Art, and the general public.

Actually, the whole meeting, aside from the technical sessions, was Northern California's first observance of Light's Diamond Jubilee. The public as well, participated, especially in the six-weeks exhibition on Light and Color which was jointly sponsored by I.E.S. and the San Francisco Museum of Art, April 5 through May 11.

Focal point of the exhibition was a specially lighted San Francisco penthouse apartment (simulated) designed by W & J Sloane and set up in the Museum for the public to see. E. W. Commery of General Electric Co., Nela Park, Cleveland, designed the lighting on the basis of an artist's sketch of the room, and christened the apartment "The Celestial Room." Cooperating in the installation were Pacific Gas and Electric Co., C. J. Holzmueller Co., Associated Lighting Co., Swivolier Inc., General Electric, Westinghouse and Sylvania.

Forty-four separate light sources, each individually dimmer-controlled in a small living room, lanai and step-up dining room, made the installation the most flexible ever seen in the San Francisco Bay area. An ellipse of recessed downlights in the ceiling, employing pink, blue, white and amber lamps, made possible

Light and Color forum included participants, l. to r., Carlton Thompson, San Diego Chapter Chairman; Walter Granville, color consultant; Don Caverly, Sylvania; Marshall Waterman, I.E.S. General Secretary, and Past-President S. G. Hibben.



Head table at the President's Dinner: left to right, Walter Granville, color consultant; Mrs. Granville; Wendell Spackman, A.I.A.; Mrs. Spackman; Conference Chairman John S. Walsh; and Mrs. Walsh; President A. H. Manwaring; Mrs. Manwaring; Frank Falge, Northern California Section Chairman; Mrs. Falge; O. R. Doerr; Mrs. Doerr; Regional V-P Leonard Hobbs; Mrs. Samuel G. Hibben; Past President Hibben; Walter Nordby, San Jose Chapter Chairman; Carlton Thompson, San Diego Chapter Chairman; Mrs. Thompson; I.E.S. General Secretary Marshall Waterman; and Professor D. M. Finch, past Chairman of the Northern California Section.

subtle variations in hue as a decorative element in the room. Fluorescent valance lamps were dimmer-controlled, another first for the West Coast. This display did much to open the eyes of visitors to the possibilities of light and color as elements in architectural and decorative design, which also formed the conference theme.

The remainder of the exhibition included models and explanations of the Ostwald, Munsell and C.I.E. color systems; demonstrations of the effect of available "white" fluorescent lamps on pigments and fabrics, an exhibition on light control illustrating the principles of light reflection, refraction and diffusion; and numerous examples of directional, silhouette, show window and other lighting.

The room devoted to light sources showed the development of electric lamps from Edison's first experimental model to today's efficient bulbs and fluorescent tubes.

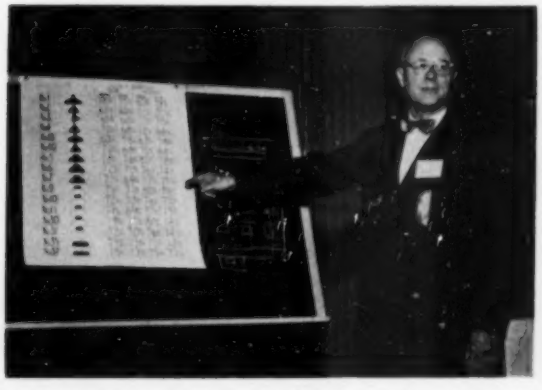
John S. Walsh, chief illuminating engineer of Pacific Gas and Electric Co., who was also general chairman of the I.E.S. conference, was principally responsible for the six-week public exhibition.

Technical Program

The papers sessions were also held in the attractive setting of the Museum, with parallel sessions on industrial lighting and street lighting at the Western Merchandise Mart. An evening demonstration meeting on street lighting was also held April 20 at the University of California field test laboratory in Richmond, with Professor D. M. Finch as host. A detailed list of the technical program is given, for the record, at the end of this report.

Social Program

As befits a meeting of this stature, an organized social program entertained delegates and visiting ladies between times. A joint luncheon was held opening day with the San Francisco Electric Club, at the Palace Hotel. Alston Rodgers, General Electric Co., Nela Park, was the speaker, on "Light's Diamond Jubilee." The ladies also had a luncheon, on Tuesday, at historic Cliff House overlooking the Pacific, and a dinner at the Spenger Fish Grotto in Berkeley preceded the evening street lighting demonstration.



Regional V-P Leonard Hobbs spoke on Industrial Lighting — Past, Present and Future, at one of the technical sessions of the South Pacific Coast Regional Conference.

John Keyes, Benjamin Electric; Jack Hamond, Pacific Gas and Electric Co.; and Conference Chairman John S. Walsh, photographed at the President's Dinner.

Alston Rodgers, G-E, spoke on "The Incandescent Lamp in Lighting Design," and addressed a noon luncheon of the San Francisco Electric Club.

Highlight of the social program was, of course, a dinner and dance honoring President and Mrs. Homer Manwaring, held in the Peacock Court of the Hotel Mark Hopkins Monday evening.

M.M.I.L.J.

San Diego Chapter will represent the South Pacific Coast Region at the National contest for My Most Interesting Lighting Job. S. V. Monsees, representing that Chapter won first prize in the Regional contest with his installation for the California Tower in Balboa Park.

Second prize in the contest was a tie — S. J. Hughes, representing Northern California Section, and D. M. Reynolds, Southern California Section.

This is the Region which won the contest last year at the New York national conference, and they're aiming for two in a row.

Papers Presented

For the record, the following papers were presented at the Eighth Annual Conference of the South Pacific Coast Region:

Monday Morning — Light Sources

Chairman, Walter Nordby
San Jose Chapter

"Lighting as an Art Form," by Dr. Grace McCann Morley, Director, San Francisco Museum of Art.
"The Fluorescent Lamp in Lighting Design," by Marshall Waterman, Westinghouse Electric Corp., Bloomfield, N. J.
"The Incandescent Lamp in Lighting Design," by Alston Rodgers, General Electric Lighting Institute, Cleveland.
"Light's Diamond Jubilee — What More Can Light Do?" by S. G. Hibben, Westinghouse Electric Corp.

Monday Afternoon — Color

Chairman, Carlton Thompson
San Diego Chapter

"Color Systems and Their Use," by Walter Granville, Container Corporation of America, Chicago.
"Color Is How You Light It," by Don P. Caverly, Sylvania Electric Products, New York.
Light and Color Forum.

Monday Evening

President's Dinner—Mark Hopkins Hotel
Chairman, F. M. Falge
Northern California Section

Tuesday Morning — Parallel Session
Residential Lighting

Chairman, Donn Emmons
Northern California Chapter A.I.A.

"Light and Color in the Home," by E. W. Commery, General Electric Lighting Institute, Cleveland.
"Functional Portables and Fixtures for the Home," by Jacob H. Blitzer, Lightolier, Inc., New York.
"Architecture and Engineering in Lighting Design," by A. Homer Manwaring, President, Illuminating Engineering Society.
"My Most Interesting Lighting Job"—Stephen W. Lindheim, Chairman, Regional Competition Committee.

Tuesday Morning — Parallel Session
Street Lighting

Chairman, W. P. Bear
Member Emeritus I.E.S.

"Lighting and Night Traffic Accidents," by David M. Baldwin, National Safety Council, Chicago.
"Street Lighting for the User," by Victor Paulsen, Yellow Cab Co., San Francisco.
"New Developments in Street Lighting Sources," by Paul Schmidt, General Electric Company, Oakland, Calif.
"The Finch-Simmons Visibility Meter," by D. M. Finch, Associate Professor, University of California, Berkeley.
"New Developments in Street Lighting Equipment," by R. E. Madigan, Line Material Co., Milwaukee, Wis.

Tuesday Afternoon — Parallel Session
Store Lighting

Chairman, Don Prideaux
Southern California Section

"Designing the Shopping Center," by Victor Gruen, A.I.A., Victor Gruen and Associates, Los Angeles.
"Seeing and Selling with Display Lighting," by D. G. Parker, Haluk Lighting Co., San Francisco.
Residential and Store Lighting Forum.

Tuesday Afternoon — Parallel Session
Industrial Lighting

Chairman, Rex Moore
Mother Lode Chapter, I.E.S.

"Lighting the New Ford Plant, Milpitas," by Harry Delo and William Reuter, Fischbach and Moore, San Francisco.

Walter Granville, Assistant Director of Design, Container Corp. of America, spoke on Color Systems and Their Use.

"Ballasts for Industrial Lighting," by Harold Gerber, The Coddington Co., San Francisco, Calif.
"It's the Upkeep that Counts," by Bert Osterman, T. L. Rosenberg Co., Oakland.
Industrial Lighting Forum.

Tuesday Evening
Street Lighting — Berkeley and Richmond

Chairman, D. M. Finch
University of California, Berkeley

Dinner at Spenger's — Berkeley.
Street Lighting Demonstration.

Credit Due

Careful organization was required for a meeting as successful as this was. Many members of the region contributed to this, directed by the following committee members:

Regional Vice-President .... Leonard A. Hobbs
Conference Chairman ..... John S. Walsh
Conference Vice-Chairman .... Charles R. Long
AIA Co-Sponsoring Committee .... John Kruse
Arrangements ..... John C. Epperson
Attendance ..... Robert L. Sawyier
Display and Decorations .... George Smedberg
Entertainment ..... William H. Friend
Finance ..... Paul Schmidt
Hotel Accommodations ..... Charles W. Macy
Ladies' Reception ..... Mrs. John S. Walsh
Membership ..... T. V. Ciampi
Papers and Program ..... H. H. Robison
Publicity ..... Harry McMasters
Registration and Reception ..... Guy de Leuze
Street Lighting ..... Gilbert A. Trosper
Transportation ..... James H. Brundage

Engineering Career Conference Aids Peoria Students and Industry

The Educational Activities Committee of the Peoria Engineering Council sponsored its third annual Engineering Career Conference, April 22. A vocational guidance program for the high school students in the Illinois community, the conference is designed to create, instill, and promote interest in and an appreciation of the many branches of engineering.

The program contained a 20-minute address on "Engineering as a Career," by F. D. Haberkorn, manager of the Central Sales Division of Caterpillar Tractor Co., followed by a moving picture of examples of engineering.

Counselors in nine general branches of the engineering profession were then available to students and parents, using props, exhibits, pictures and literature to answer questions and provide information on their phase of work. Three to five counselors attended each of these groups: civil, chemical, electrical, mechanical, industrial, metallurgical, architectural, agricultural and aeronautical. I.E.S. member, James Brown of Central Illinois Light Co., spoke for illuminating engineering in the electrical session.

R. S. Frank, President of the Peoria Engineering Council presided at the meeting, which was held at the Peoria High School. The Central Illinois Chapter of I.E.S. is one of the 17 sponsoring societies of the Council.

President Manwaring, center, with Committee Chairmen W. F. Nottelman, Amalgamated Electric (left), and E. W. Green of Canadian G-E (right).

Fellows of I.E.S. in Canada — l. to r., J. W. Bateman, G. F. Mudgett, and R. M. Love.

Canadian Region of I.E.S. Holds Eleventh Annual Conference in Toronto

The Society's most wide-spread Region, the Canadian, attracted delegates from all far-flung borders to its eleventh annual Conference. Their Regional was a three-day affair, April 28, 29 and 30 at the King Edward Hotel in Toronto. Had they given a prize for distance traveled, it would be a toss-up between the Maritime Chapter 1000 miles to the east, and Winnipeg, another thousand miles to the west. From all its Sections and Chapters, attendance was 131 registered, which swelled to about 200 for the banquet; some 150 people attended each of the two luncheons.

The conference, Canada's most important lighting meeting, featured an especially valuable papers program. Eighteen papers were presented, all of major importance, and in addition three other luncheon addresses. Preprints of all papers were available to each delegate as he registered — a convention-type touch of considerable value.

Many features of Canadian Regional Conferences especially are frequently convention-type. The importance of the gathering is sensed throughout, by all who attend. It is felt both for the papers presented, and the fun planned.

Papers

A detailed list of the technical program is given at the end of this report. Several worth while innovations for a regional program were a feature. An exceptionally good session was presented on residence lighting, for instance, including a comprehensive paper on Canada's program of wiring standards for homes. An interesting point made by the speaker (F. J. Mowat of the Electric Service League of Ontario) was that standards set by "Red Seal" for residential electrical installations in Ontario are approved by Central Mortgage and Housing Corp., the "F.H.A." of Canada. Financing arrangements of new or rebuilt homes include complete adequate wiring specifications.

At the Canadian Regional Conference, Dr. S. K. Guth of Nela Park; M. B. Hastings, Canadian Regional V-P; D. M. Jones, Vice-President of I.E.S.

My Most Interesting Lighting Job winners received prizes from M. B. Hastings, left, Canadian Regional V-P. Receiving check for first prize is Paul Ducasse, Quebec Chapter while R. L. Lucas, Ottawa Chapter, second prize, looks on.

"History with a Smile" — high jinks at the banquet was an educational and hilarious skit executed by members of the Montreal Section.

Allouette — at the Get Acquainted Party, Dennis Thereault of Quebec City sparking the singing.

Delegates went home with new ideas and good background for thinking, following many papers — among others, those presented by Dr. S. K. Guth, Professor K. B. Jackson, R. C. Allison, Frank G. Reed and Don Caverly, for instance.

How did it work, having two and a half days of program? The closing half-day session following the dance, at that? The third day's morning (closing) session had the largest attendance of all the sessions during the entire conference.

My Most Interesting Lighting Job

Two chapters were entered in the Canadian Regional contest for "My Most Interesting Lighting Job." These were the Ottawa Chapter represented by the winner of their contest, R. L. Lucas, Canadian G-E. His installation at his company's office in Ottawa took second prize in the Regional contest.

Mr. Paul Ducasse of Terreau-Racine Ltee., Quebec, won first prize and the honor of representing Canada at the national contest in Atlantic City. His installation featured a design for a Quebec furniture store.

Entertainment

One item of the fun program on the Canadian Regional should be repeated at the National Conference. This was a skit worked up by several members of the Montreal Section and presented at the banquet session. Conceived and written by the cast, its hilarious nature at the same time was a sugar coating for a bit of very good lighting education. While this skit would have to be seen to be appreciated, a list of the characters gives some idea of its format: Edison (reviewing the past 75 years and looking at the present developments); and, in wonderful costumes representing their character, Lumen, Footcandle, Glare, Shadow and Color. What's more it was all in verse, and ended with special "Lighting" lyrics. Good illumination principles were not all that the song proved. It established also that uninhibited enthusiasm is a good substitute for a singing voice under circumstances like these.

The cast and perpetrators of this wonderful idea were: Thomas Edison—Eddy Morris; 1st Commentator—Joe Thomas; 2nd Commentator—Roy Eshelby; Loopy Lumen—Bob Tate; Footcandle—Duncan Brooks; Glare—Ewart Haacke; Shadow—Joe Thomas; Color—Bill Massie. The show was produced and directed by Roy Eshelby.

The skit, of course, was only one item of the entertainment. An informal get-acquainted party was held on the evening of the opening day. It turned out to be a very good idea. The fun centered around the piano and accordionist, who though professionals, were in the end only accompaniment to I.E.S. singing talent. With emphasis on songs from the twenties and allouette.

Master of Ceremonies for the banquet was M. B. Hastings, Regional V-P. To him in this role fell the honor of presenting for the Toronto Section a brooch, a replica of Queen Elizabeth's wedding present from Canada, a sparkling Maple Leaf, to Mrs. Manwaring.

Good Ideas

At the Wednesday luncheon a special table was arranged near the speakers table for Sustaining Members of the Canadian Region. President Manwaring introduced each of these members and presented certificates of membership to several new ones.

At the dance each lady was given a fresh-cut rose for her dress. There were several different colors to choose from.

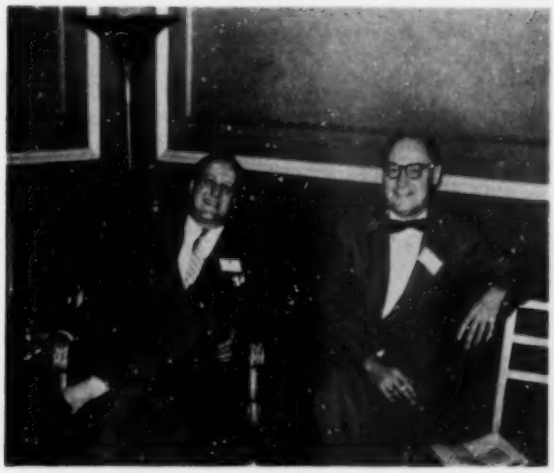
Coffee meetings for ladies are not uncommon, but in Toronto, coffee breaks for the men in the middle of morning sessions were a welcome recess.

A nice touch in Canada is a man especially delegated to thank each speaker, formally, following his address.

A press conference held the evening before the opening session gave newsmen an opportunity to interview such speakers as Dr. S. K. Guth, Dr. S. G. Hibben, President Manwaring and others. Publicity for the conference was professionally handled by David F. Knudsen, Editor of *Electrical News and Engineering*, a member of I.E.S.

(*Continued on page* 11A)

Photos of the Canadian Regional Conference are courtesy of David F. Knudsen, Editor, *Electrical News and Engineering*, Toronto.



R. C. Allison, T. Eaton Co., left, with Don Caverly, Sylvania, at the Canadian Regional. Both were speakers on the technical papers program.

W. E. Reny, Ottawa Chapter Chairman, left, with Frank Jeffrey, Chairman of the Canadian Region's Contest for My Most Interesting Lighting Job.

(Continued from page 10A)

TECHNICAL PROGRAM

For the record, the detailed program was as follows:

Wednesday Morning

Chairman — M. B. Hastings
Canadian Regional Vice-President

Official Opening of Conference—M. B. Hastings, I.E.S. Canadian Regional Vice-President.
Civic Welcome to Delegates — His Worship Allan A. Lamport, Mayor of Toronto.
Vice-President's Address—Duncan M. Jones, Senior Vice-President, I.E.S.
President's Address—Mr. A. Homer Manwaring, President, I.E.S.
Contributions of Research to Better Quality Lighting—S. K. Guth, Lamp Department, General Electric Co., Cleveland, Ohio.

Luncheon

Chairman — J. D. Harrison
Toronto Section

Light's Diamond Jubilee—Samuel G. Hibben, Lamp Division, Westinghouse Electric Corp., Bloomfield, N. J.

Wednesday Afternoon

Chairman — J. M. Gaskin
Hamilton Ontario Chapter

Economics of Luminous Ceilings—R. A. Yates and R. D. Burnham, Wakefield Lighting Ltd.
Lighting Toronto's Subway—J. T. Harvey, Toronto Transit Commission and B. I. McCall, Mitchell Mfg. Co. Ltd.
Three Dimensional Seeing—Professor K. B. Jackson, University of Toronto.
Stereo Views of Successful Lighting Installations—M. K. Strang, Curtis Lighting of Canada, Ltd.
Get Acquainted Party—Elizabeth Room.

Thursday Morning

Chairman — W. E. Reny
Ottawa Chapter

Colored Floodlighting and Decorative Lighting —R. A. Eshelby, Northern Electric Co. Ltd. and C. A. Albini, British General Electric Co. (Canadian) Ltd.
My Most Interesting Lighting Job—Contest to select winner of Canadian Region Contestants—R. O. Lucas and P. A. DuCasse.
Light and Light Conditioning—R. C. Allison, T. Eaton Co. Ltd.
C.S.A. Lighting Activities—G. F. Dean, Toronto Hydro-Electric System.

Luncheon

Chairman — R. K. Owen
Montreal Section

Speaker—Ken McTaggart of the Globe and Mail.

Thursday Afternoon and Evening

Chairman — Oscar Durval
Quebec Chapter

Interior Decoration—W. E. Tucker, The T. Eaton Co., Ltd., College St. Store.
Trends in Design of Residential Luminaires—Frank G. Reed, John C. Virden Co. Ltd.
Adequate Wiring for Homes—F. J. Mowat, Electric Service League of Ontario.
Trends in Home Lighting—Miss Margaret Lidstone, Canadian General Electric Co. Ltd.
Film—A Bright Future.
President's Reception—Sheraton Annex.
Dinner—Sheraton Room.
Dancing—Sheraton Room.

Friday Morning

Chairman — F. C. Mayberry
Conference Chairman

Store Lighting—D. P. Caverly, Sylvania Electric Products Inc.
Economics of Lighting Systems — N. W. Bethune, Robertson-Irwin Ltd.
Factors Affecting Efficiency of Fluorescent Luminaires—H. F. Davidson and M. G. Currie, Research Division, The Hydro-Electric Power Commission of Ontario.
Latest Development in Rapid Start Fluorescent Lamps—J. W. Bateman, Canadian General Electric Co. Ltd.
Closing Ceremonies.

CREDIT DUE

Chairman of the Conference was F. C. Mayberry, Canadian National Exhibition.

Secretary was Grant E. Davidson. Their responsibilities were greatly lightened by the aid of the following committee members:

Regional Conference Committee—M. B. Hastings, Chairman.
Ladies' Committee—M. Lidstone.
Papers Committee—H. F. Davidson.
Hotel Committee—E. W. Green.
Registration Committee—K. V. Knudsen.
Entertainment Committee—W. F. C. Nottelman.
Finance Committee—J. C. Wilson.
Publicity Committee—D. F. Knudsen.
Decorations Committee—F. J. Dahmer.
Transportation Committee—R. Fell.
Committee at Large—J. W. Metelnick
My Most Interesting Lighting Job—F. R. Jeffrey.

Annual Student Contest Sponsored By Cleveland I.E.S.-A.I.A.-S.I.D.

Winners of the fourth annual Student Design Competition, sponsored jointly by the Cleveland I.E.S., the American Institute of Architects, and Society of Industrial Design, were announced at a banquet at the Allerton Hotel in Cleveland, April 28.

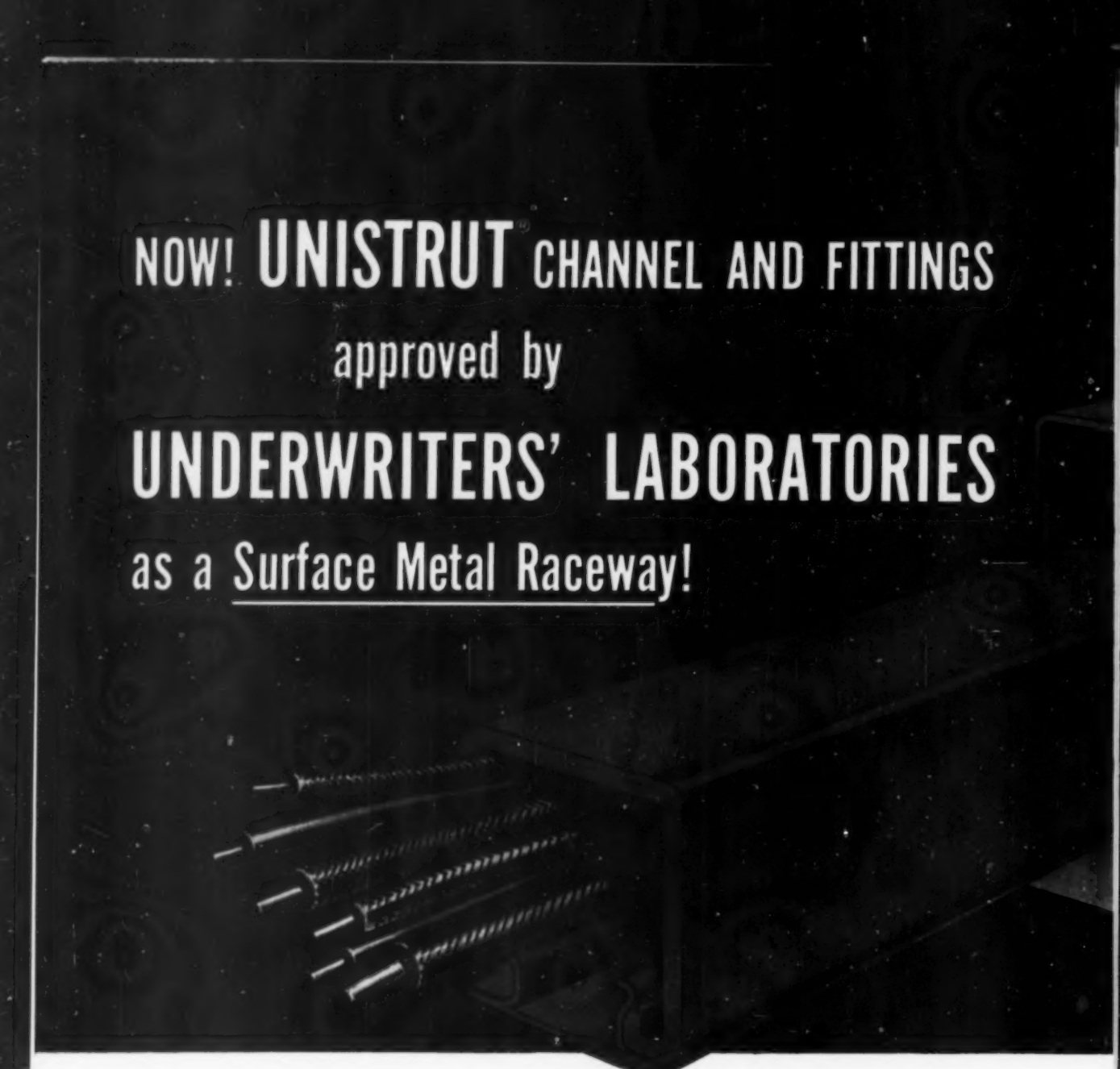
Winner of the $80 first prize was a team consisting of Alexander Papesh and Patrick Zabaldo of Western Reserve University, A. Fredrickson and R. L. Tubbesing of Case Institute of Technology, and Stanley Carpenter of Cleveland Institute of Art. The $60 second prize went to John Gerba and Ronald Keske of Western Reserve, Eugene Atkisson of Case, and Russell Bolt of the Art Institute. Third prize of $40 was awarded to Eugene Sagadencky and Nick Vodanoff of Western Reserve, John C. Hull and Andrew Marfut of Case, and Ed Jaquet of the Art Institute. A total of ten teams competed for the prizes.

The problem for this year was to design a Service Center for the Ohio Turnpike. Each team was required to submit detailed plans of all the buildings and parking facilities as well as interior color schemes and complete electrical wiring plans. A restaurant seating 160 people and providing counter service for another 50 people; with lounge, gift shop, kitchen, and offices was one of the two main buildings. The second main building was the service station, which required facilities for passenger cars, trucks, and buses.

The students had six weeks to complete their projects. During that time three series of lectures were presented to assist in developing a solution. The first of

(Continued on page 14A)

NOW! UNISTRUT® CHANNEL AND FITTINGS approved by UNDERWRITERS' LABORATORIES as a Surface Metal Raceway!



In this building, UNISTRUT was used to support and wire a lighting installation on a concrete ceiling. Savings over conventional methods of installation were estimated at *fifty per cent* Note the neat appearance and perfect rows of fixtures.

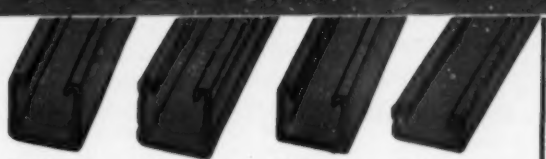
Lighting for a large manufacturing plant was solved fast at low cost by using UNISTRUT for support and wiring. Even on ceiling arrangements as this, using two types of fixtures, UNISTRUT installs quickly and easily.

Long popular as a quick-erected, low-cost method of lighting support, UNISTRUT channel and fittings have now been approved for use as a surface metal raceway...for wiring lighting installations and for supplementary power wiring of machines, motors, other lighting rows, etc.

Faster, Lower Cost Installation

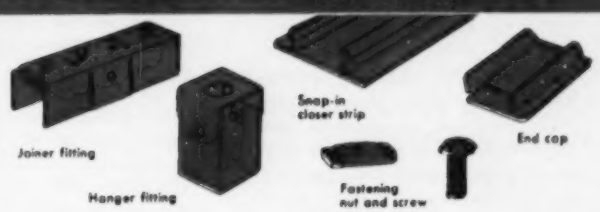
The UNISTRUT system is quick and easy to erect from stock parts. No wire pulling necessary as wires are *laid in* the channel and closer strip snapped in place. Continuous channel support permits wider spacing of hanger stems, greatly simplifying installation and re-

UNISTRUT GOES UP FAST FROM STOCK CHANNEL AND FITTINGS!



Four sizes of channel

UNISTRUT offers a choice of channel sizes for every type of lighting installation. Here you will find a size channel for weight and wire-carrying capacity to fit your particular needs.



Simple, standard fittings

These are the five basic fittings that form, with the channel, the UNISTRUT system of light support and wiring. Only a screw driver is needed to assemble the entire system.

ducing costs. Power lines tapped from the channel for supplementary wiring eliminate special lines and extra cost.

Neat Appearance, Complete Flexibility

Straight, strong and rigid, UNISTRUT channel gives lasting true alignment that's undisturbed by servicing. Concealed wiring eliminates unsightly external power lines. Fixtures may be attached anywhere along channel length...ideal for continuous run or spaced fixtures. Attachment of hanger stems at any point on channel permits quick, simple installations in spite of ceiling irregularities.

Ask to see the UNISTRUT Demonstrator Car

The World's Most Flexible All-Purpose Metal Framing

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Write today for free copy of bulletin FF-3 and Underwriters' Laboratories specifications.

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(Continued from page 11A)

these, held at the Art Institute, was a discussion of the problem, in general, by speakers from The Turnpike Commission, Standard Oil Company of Ohio, and the Stouffer Restaurant Chain. The second meeting, held at Nela Park for the Student Designers and Architects, was concerned with lighting fundamentals. The final meeting was held at Westinghouse Lighting Division and covered lighting applications, indoor and outdoor, with special reference to the problem.

The following men acted as advisors to the students:

Architects: Clyde Patterson, Carl Droppers, George Danforth.

Interior Design: Onnie Mankki.

Industrial Design: E. Smith, Victor Schiengost.

Electrical Engineers: Russell Putnam, Wilbur Riddle.

Awards were based on creative imagination and sound, discriminating judgment. Judges for the event were all well-known men in their field: A.I.A. — R. Gaede and Douglas Maier; I.E.S. — Edward Millar and C. M. Cutler; S.I.D. — R. A. Smith; and for the Turnpike Commission — Gordon McKay. Mr. McKay invited the winning team to Columbus to present its plans to the commission.

Following the awards, Mr. Robert Hose, partner in the New York firm of Henry Dreyfuss, Incorporated, and National President of the Society of Industrial Design, presented a selection of industrial design problems and their solutions.

Lighting Maintenance Contractors Organize New Group

The first annual conference organizing the National Association of Lighting Maintenance Contractors was held in Cincinnati, Ohio, May 19 through 21, at the Sheraton-Gibson Hotel.

Officers elected at the organizational meeting are:

President—Walter Fink, Senior Fluorescent, Inc., Atlanta, Ga.
Secretary-Treasurer—Luther Nunnally, Fluorescent Maintenance Co., Birmingham, Ala.
Regional Vice-Presidents:
Northern—Francis Clark, Lighting Services, Waterbury, Conn.
Central — Edward Creed, C&S Lighting Maintenance Co., Cleveland, Ohio.
Southern — George Kort, Maurys Fluorescent & Appliance Service, Louisville, Ky.
Western — Herbert Mendelsohn, Sun Ray Lighting Corp., Kansas City, Mo.

The officers constitute the Finance and Membership Committees. A Committee on Sales Methods and Training and Market Analysis was formed with Samuel Feldman, Aetna Electric Co., Allston, Mass., as chairman.

ATTENDING the Residence Lighting meeting in Pittsburgh are: left to right, standing, E. W. Commery, Mary Dodds, Y. L. Ripley, Frank Marriett, A. C. Bredahl, Frank Kitzmiller, Norman Vacha, C. L. Crouch; seated, Blanche Waggener, Katherine Goodall, Myrtle Fahsbender, Eve Freyer, Helen M. Castle, Kaye Leighton, Jan Reynolds, Aileen Page, Mary Webber, Priscilla Presbrey.

Residence Lighting Groups Hold Joint Meeting in Pittsburgh

The Greater Pittsburgh Airport Hotel was the scene of a two-day joint meeting, May 12 and 13, of three I.E.S. committees in the home lighting field: the technical Residence Lighting Committee, the national Residence Lighting Forum Committee and the Home Lighting Data Sheet Committee. The first day was devoted to discussions of the scopes of the three committees, their interrelation, problems and plans for correlation and promotion of future work. The second day representatives from the following groups outlined their activities in the home lighting field: Adequate Wiring Bureau, American Home Lighting Institute, Better Light-Better Sight Bureau, Edison Electric Institute, General Electric Co., Westinghouse Electric Corp., and Sylvania Electric Products, Inc.

For the Adequate Wiring Bureau, A. C. Bredahl discussed the newly revised Handbook for Interior Wiring Design, and copies were distributed to members of the Residence Lighting Committee; Mr. Bredahl is one of the I.E.S. representatives on the Industry Committee on Wiring, which prepared the handbook, and the I.E.S. will be asked to endorse it. Mrs. Helen M. Castle stated that the A.H.L.I., now under new management, hopes to revitalize the built-in lighting market; twenty fixture manufacturers and two lamp companies are members. Frank Fitzmiller of E.E.I. explained the new "Beauty-Plus" portable lamp tagging and promotion program which they are sponsoring.

The group dined at the airport's Horizon Room and had a tour of the airport lighting and C.A.A. facilities.

I.E.S. Conference To Entertain I.E.C. Delegates

An organized trip to Atlantic City to visit the I.E.S. National Technical Conference is planned by the Executive Committee of the International Electrotechnical Commission, which is holding its Golden Jubilee in Philadelphia, September 1 to 16. The Commission has planned its sessions on light sources and lighting for the first week in September, so that delegates interested in this phase of electricity can take in the I.E.S. meetings during the following week.

Arrangements are being made to provide copies of the I.E.S. Conference program to be included in the material furnished to the I.E.C. delegates. The Electrotechnical Commission anticipates the atendance of about 250 from abroad as well as representatives from the United States.

Awards Announced in New York Lighting Design Contest

Results of a Lighting Design Competition for New York City High School students, sponsored by the I.E.S. New York Residence Lighting Forum, have been announced. The competition, a yearly event, is open to all students in the vocational high schools of the New York City system, and this year involved making complete plans for the artificial lighting of a typical split level residence. Contestants were given the floor plan of the house showing furniture arrangements and information as to the habits and interests of the family for whose

(Continued on page 17A)

IF YOU SPECIFY OR BUY FLUORESCENT FIXTURES:

Here is why General Electric believes you should insist on series ballasts for 96T12 lamps

Several years ago, our engineers studied the merits of the series-type ballast circuit for operating the 96T12 lamp at 425 ma. It showed real possibilities for economy, both in ballast cost and size. With concentrated efforts, a series ballast design for this lamp was perfected. Then for the first time, a series-type ballast circuit meeting all lamp requirements and giving full rated lamp life was made available to you.

Actually, there was nothing basically new about the series-type ballast. As early as 1940, our engineers had studied such a circuit. As new lamps were made available over the years, the series ballast was investigated time and again. However, prior to the 96T12 lamp, the potential savings of the series ballast circuit had been discarded because no way had been found to meet lamp operating requirements.

During those years the lead-lag ballasting circuit was widely used for the various types of lamps then available. Naturally, this type of ballast gained wide acceptance in the lighting industry as the standard of ballast quality.

After the 96T12 lamp was introduced, a series ballast was developed which proved to be the best ballasting tool for this important new lamp. However, there was real hesitancy about accepting a series ballast for the 96T12 because in the past, a lead-lag ballast had been found superior for other lamps.

We felt compelled to face this challenge and advocate the series ballast for the 96T12 lamp because, everything considered, we believe it is the best ballasting tool for that lamp—giving equivalent performance in accordance with lamp specifications and offering a very substantial saving in cost and size.

The results are now known throughout the lighting industry. Millions of series ballasts for operation of 96T12 lamps at 425 ma have been furnished to the industry in the last three years by ballast manufacturers. And because series ballasts for this lamp are inherently 20% less costly—even more millions of dollars in basic ballasting cost have been saved for fluorescent lighting users.

It will continue to be our policy to use our engineering know-how and detailed knowlege of lamp requirements to produce and promote the sale of the very best ballast or selection of ballasts for every type of lamp. Whether lead-lag, series, or some completely new type of circuit, in our sincere best judgment, they will always represent the best ballast design to meet lamp and industry requirements. General Electric Company, Schenectady 5, New York. 401-4

Progress is our most important product

GENERAL ELECTRIC

CFI DAY-LINE®

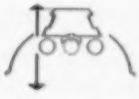
(COMFORT FOR INDUSTRY)

Easy to handle

Easy to install

Contractor features include knockouts and fittings for pipe, chain, stem and messenger cable suspension; no-sag, no-bend one-piece reflector; simplified wiring.

AND LOOK AT THESE USER FEATURES THAT DELIVER EXTRA VALUE AND SATISFACTION TO YOUR BUYERS!



COMFORT FOR INDUSTRY. Die-embossed apertures in reflectors provide 10% up-lighting for improved visual comfort and freedom from irritation and nervous fatigue due to eye-strain.

ALL-WHITE PORCELAIN REFLECTORS. Outside as well as inside, entire one-piece reflector is finished in snow white porcelain enamel—providing maximum high reflection surface.

COOLER, CLEANER OPERATION. A gentle flow of air passes through the apertures reducing dirt and dust deposits. This "breathing" action keeps fixture cooler, cleaner and more efficient.

TURRET* SOCKETS. Sturdy, vibration-proof Turret sockets are standard equipment on all CFI DAY-LINEs—providing positive lamp seating and simple lamp installation or removal.

*® G. E. Co.

THE CFI DAY-LINE ON THE JOB. Note how uplighting cuts down uncomfortable brightness contrast. CFI DAY-LINE is available in 2 and 3 lamp (75W) open-end 8 ft. Slimline units, 2 and 3 lamp (40W) open- and closed-end 4 ft. RAPID-START Fluorescent units, 2 lamp (90W) open- and closed-end 5 ft. Fluorescent units with NO-BLINK starters.

Day-Brite Lighting, Inc., 5432 Bulwer Avenue, St. Louis 7, Missouri. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ontario.

"DECIDEDLY BETTER" DAY-BRITE *Lighting Fixtures*

421

CALL OR WRITE YOUR NEAREST DAY-BRITE REPRESENTATIVE

(Continued from page 14A)

activities the lighting is provided. Entries were judged on the success with which they solved the lighting problems, major consideration being given to practicality, comfort and aesthetic merit, as well as to the technical rendering of the presentation.

Judges were Miss Lillian Eddy, Home Lighting Specialist with General Electric in New York, Thomas Smith Kelly, consultant, and Berlon Cooper, *Electrical Construction and Maintenance*. Harold J. Peters, Chairman of the Lighting Design Competition of the Forum and Dr. Seelig Lester, Supervisor of Related Technical Subjects for the Board of Education, were in charge of arrangements in the schools.

The sixteen awards were made and the winning entries exhibited at a tea meeting of the Forum June 1, at the Central High School of Needle Trades in New York City.

Winners were:

First Prize — Frederick Crockett.

Second Prize — Carl Procida.

Third Prize — Salvatore Sigona.

Special Awards — Joseph Uliano, Spiros Katechis, William Jules, Earle C. Pringle, Saverio Croce.

Honorable Mentions — Norman Severin, A. J. Webster, Jr., F. T. Pickett, Jr., John Palmer, Frank Rasmussen, Martin Lebowitz, Carl Malchiodi, C. V. Fluker.

Five high schools were represented by the winning entries.

Office Lighting Forum Airs All Viewpoints

A forum on how to get better office lighting, planned to present the viewpoints of owner, architect, consulting engineer, contractor, and utility, was sponsored May 27 by the Northern California Section of I.E.S., at St. Julian Restaurant in San Francisco.

The panel of speakers, representing every element of the industry included:

The Owner—F. Willard Gray, representing the National Office Management Association.
Architect—W. B. McCormick, A.I.A., Harzka and Knowles.
Consulting Engineer—Harold A. Wright.
Contractor—Fay Lemoge, Lemoge Electric Co.
Utility—C. W. Macy, Pacific Gas and Electric Co.

Moderator at the forum was Matt Cabot, Day-Brite Lighting, Inc. Milton C. Very, of Fluorescent Fixtures of California, presided.

Engineering Society Executives Hold Two-Day Meeting in Detroit

The Council of Engineering Society Secretaries met in Detroit, May 20 and 21 with an attendance of 33, representing national Canadian and American societies, regional groups and local engineering clubs.

The program was conducted as a panel discussion, with six groups of related topics, one panel being under the chairmanship of I.E.S.'s A. D. Hinckley.

The program included panels on the following topics:

Publication—Policies—Methods—A. R. Putnam, American Society of Tool Engineers, Leader.
Headquarters' Facilities—C. S. Pearce, American Ceramic Society, Leader.
Office Administration—John Zecca, American Society of Civil Engineers, Leader.
Membership—C. S. Doerr, Philadelphia Engineers Club, Leader.
Inter-Society Relations—M. C. Turpin, American Society of Refrigerating Engineers, Leader.
Miscellaneous — A. D. Hinckley, Illuminating Engineering Society, Leader.

During the course of the meeting, the secretaries visited the building owned and operated by the American Society of Tool Engineers. A tour was also made of the building of the Engineering Society of Detroit, in which the sessions were held.

New York Architectural Contest Attracts 80 Student Entries

About 80 senior and graduate students from the schools of Architecture at Pratt Institute and Columbia University participated in the architectural competition held recently by the New York Section of I.E.S.

The problem was the architectural layout and technical illumination of an art gallery to be constructed as an alteration to an existing structure on 57th St., in New York City. Winners were:

First — Harry B. Mahler, Columbia University.

Second — R. L. Sutnar, Pratt Institute.

Third — Frank Pisani, Pratt Institute.

Prior to the actual solution of the problem by the entrants a lecture on the subject of museum and gallery lighting was delivered at each school by Laurence Harrison, illuminating engineer who has been consultant to the Metropolitan Museum of Art in their relighting program.

Judges for the competition were Architects Walker O. Cain, of Mekim, Mead & White, and J. Stanley Sharp of Ketchum, Gina & Sharp, and Professional Engineer Alex Sitkin of the consulting firm of Mongitore & Moesel.

Beauty Parlor Operators Learn of Lighting Techniques

"Beauty in a New Light" — a double-edged program featuring both an education in improved lighting for beauty parlors and barber shops and a demonstration of new techniques in hair styling — was sponsored recently by the Western Massachusetts Electric Co., John H. Breck Inc. and the General Electric Co., in Springfield, Mass. Jack O. Callander, I.E.S. Local Representative in Spring-

(Continued on page 18A)

ENGINEERING Society Secretaries on tour at the headquarters of the American Society of Tool Engineers in Detroit. Observing an automatic addressing operation are, l. to r.: W. E. Bryan, Engineers Club of St. Louis; Nancy Morgan of the Tool Engineers headquarters; W. P. Young Claus, Jr., American Society of Lubricating Engineers; A. D. Hinckley, of I.E.S.; John Zecca, American Society of Civil Engineers; Nelson Hibshman, American Institute of Electrical Engineers.

(Continued from page 17A)

field was in charge of arrangements for Western Massachusetts Electric.

The idea back of the meeting, which attracted 226 attendance, was to present an interesting program, highlighted with a subject the customers were interested in and familiar with, and then supply the lighting information. Speaking for the lighting section were Miss Irene Wright of Western Massachusetts Electric Co. and Kenneth Estler of General Electric.

The John H. Breck Co. is a Springfield firm, and this new idea of getting their present and future customers together has taken on a national outlook, since they plan to repeat it in other parts of the country, working with the lighting departments of local utilities.

I.E.S. Officers Elected For Year 1954-1955

At a meeting of the I.E.S. Council held June 10, 1954, the report of the Committee of Tellers was presented, giving the results of the recent election of officers for the coming year, beginning October 1, 1954. The following have been elected to the offices indicated.

General Officers

President—Duncan M. Jones, Curtis Lighting of Canada, Ltd., Montreal, Que.

Vice-President — Marshall N. Waterman, Westinghouse Electric Corp., Bloomfield, N. J.

General Secretary—Kirk M. Reid, General Electric Co., Cleveland, Ohio.

Treasurer — George J. Taylor, Day-Brite Lighting, Inc., Ney York, N. Y.

Directors (Until 1957) — L. C. Twichell, Rochester Gas and Electric Corp., Rochester, N. Y. and John S. Walsh, Pacific Gas and Electric Co., San Francisco, Calif.

Regional Vice-Presidents — Great Lakes Region, A. C. Sangster, Detroit Edison Co., Detroit, Mich. *Midwestern Region*, J. R. Chambers, Benjamin Electric Mfg. Co., Des Plaines, Ill. *Northeastern Region*, C. W. McCormick, Connecticut Light & Power Co., Waterbury, Conn. *Pacific Northwest Region*, Blair E. Plowman, Washington Water Power Co., Spokane, Wash. *South Pacific Coast Region*, Dan M. Finch, University of California, Berkeley, Calif.

British Columbia Section

Chairman—T. H. Doherty, North Vancouver, B. C. *Vice-Chairman*—J. H. Gilbreath, North Vancouver, B. C. *Secretary-Treasurer*—G. H. Wheatley, Canadian General Electric Co., Ltd., Vancouver, B. C. *Board of Managers*—A. H. Cocking, E. N. Kolbeins, D. McGregor, J. R. Walker.

Capital Section

Chairman—Dorothy Nickerson, U. S. Dept. of Agriculture, Washington, D. C. *Vice-Chairman*—Benjamin Goodman, National Electric Wholesalers, Washington, D. C. *Secretary-Treasurer*—H. V. Oerting, Potomac Electric Power Co., Washington, D. C. *Board of Managers*— S. W. Charlesworth, C. R. Engle, Jr., A. J. Rugo, J. F. Wueste.

Carolinas Section

Chairman—Gordon Wells, The Gordon Wells Co., Charlotte, N. C. *Vice-Chairman*—B. C. Swaim, Beberstein & Borries, Inc., Charlotte, N. C. *Secretary-Treasurer* — Daniel Barcik, Benjamin Electric Mfg. Co., Charlotte, N. C. *Board of Managers*—J. M. Foreman, Jr., J. W. Johnston, C. C. Jordan, R. C. Marshall, Jr.

Central New York Section

Chairman—R. H. Goodman, Crouse-Hinds Co., Syracuse, N. Y. *Vice-Chairman*—William McNulty, Jr., Graybar Electric Co., Syracuse, N. Y. *Secretary-Treasurer* — E. L. Moyer, Jamesville, N. Y. *Board of Managers*—P. J. Carpenter, W. S. Cortright, D. L. Killigrew, R. C. Ladouceur.

Chicago Section

Chairman—A. P. Larson, Commonwealth Edison Co., Chicago, Ill. *Vice-Chairman*—R. J. Diefenthaler, General Electric Co., Chicago, Ill. *Secretary*—E. H. Church, Benjamin Electric Mfg. Co., Des Plaines, Ill. *Board of Managers*—J. R. Chambers, C. W. Clarkson, W. M. Coffey, C. F. Jensen.

Cleveland Section

Chairman—F. L. Detwiler, Cleveland Electric Illuminating Co., Cleveland, Ohio. *Secretary*—J. G. Mitchell, Grant Electric Co., Cleveland, Ohio. *Board of Managers*—R. W. Morris, J. J. Neidhart, R. M. Smart, G. K. Warner, R. G. Zimmerman.

Connecticut Section

Chairman—R. O. Mills, Waterbury, Conn. *Vice-Chairman* — L. A. Senofonte, American Electric Supply Co., Hartford, Conn. *Secretary*—R. D. Babcock, General Electric Co., New Haven, Conn. *Board of Managers* — Francis Clark, E. R. Cole, H. S. Kelly, William Richards.

Eastern Pennsylvania Section

Chairman — Paul A. Kinsey, Metropolitan Edison Co., Reading, Pa. *Vice-Chairman* — F. M. Gochenaur, Pennsylvania Power and Light Co., Lancaster, Pa. *Secretary-Treasurer* —J. L. Beaver, Metropolitan Edison Co., Reading, Pa. *Board of Managers*—D. C. Fritzinger, G. M. Hooks, R. D. Howe, E. W. Kelsey.

Georgia Section

Chairman — Paul P. Harrison, Sylvania Electric Products Inc., Atlanta, Ga. *Vice-Chairman*—Judd Lough, Holophane Co., Inc., Atlanta, Ga. *Secretary*—W. F. Johnson, Georgia Power Co., Atlanta, Ga. *Board of Managers*—R. E. Lawler, W. M. Pearson, J. D. Poage, J. E. Sweatte.

Heart of America Section

Chairman—Francis P. O'Connor, St. Joseph Light & Power Co., St. Joseph, Mo. *Vice-Chairman*—R. R. Marvin, General Electric Co., N. Kansas City, Mo. *Secretary*—C. W. Thorsell, Tom Fielder Co., Kansas City, Mo. *Board of Managers*—F. I. Feagans, J. L. Krall, J. G. McDonald, F. E. Miles.

Iowa Section

Chairman — Richard Holcombe, Interstate Power Co., Dubuque, Ia. *Vice-Chairman*—R. R. Engelmann, Westinghouse Electric Co., Des Moines, Ia. *Secretary*—M. H. Galbraith, Cedar Rapids, Ia. *Board of Managers*—P. D. Anderson, D. F. Clutter, H. W. Johnson, H. R. Weibel.

Maryland Section

Chairman—George F. Walter, General Electric Co., Baltimore, Md. *Vice-Chairman*—E. R. White, III, McNeill & Baldwin, Baltimore, Md. *Secretary-Treasurer*—J. C. Riley, Graybar Electric Co., Inc., Baltimore, Md. *Board of Managers*—C. J. Berry, L. W. Morgan, C. E. Sparrow, Jr., G. W. Younglove.

Michigan Section

Chairman—Floyd W. Sell, Detroit Edison Co., Detroit, Mich. *Secretary* — Harry R. Robbins, General Electric Co., Detroit, Mich. *Board of Managers*—E. R. Domoney, E. L. Fairchild, J. F. Finn, E. W. Pratt, R. S. Rogge.

Milwaukee Section

Chairman—Thomas B. Dustin, Milwaukee, Wis. *Vice-Chairman*—B. R. Bunn, Westinghouse Electric Supply Corp., Milwaukee, Wis. *Secretary*—William Lisch, Lisch Electric Co., Milwaukee, Wis. *Board of Managers*—M. H. Bruesewitz, H. W. Grosh, J. H. Hausler, W. C. Kuhnke.

Montreal Section

Chairman—Ewart M. Haacke, J. A. Wilson Lighting & Display, Ltd., Montreal, Que. *Secretary*—Duncan Brooks, Shortall Electric Co., Ltd., Montreal, Que. *Board of Managers*—C. A. Albini, M. A. Decarie, Victor Oldham, A. G. V. Smith, Joe Thomas.

New England Section

Chairman—E. J. Perkins, South Weymouth, Mass. *Vice-Chairman*—W. B. Elmer, Wheeler Reflector Co., Boston, Mass. *Secretary*—Warren K. Lewellen, Bedford, Mass. *Board of Managers*—W. L. Ball, C. M. Holden, T. C. Sargent, N. E. Ticehurst.

New Orleans Section

Chairman—Arthur A. Levy, Interstate Electric Co., New Orleans, La. *Vice-Chairman*—J. M. Gensburger, New Orleans Public Service Co., New Orleans, La. *Secretary*—S. Conrad Berdon, New Orleans Public Service Co., New Orleans, La. *Board of Managers*—C. E. Corrigan, W. T. Faber, L. N. Goodman, A. C. Roche.

New York Section

Chairman—L. R. Anderson, General Electric Co., New York, N. Y. *Vice-Chairman*—Louis Goren, Globe Lighting Products, Inc., New York, N. Y. *Secretary*—G. G. Rae, Holophane Co., New York, N. Y. *Board of Managers*—F. W. Fulle, H. J. Peters, H. J. Wald, R. L. Zahour.

Northern California Section

Chairman—James E. Barnes, Pacific Gas & Electric Co., San Rafael, Calif. *Vice-Chairman*—Harold A. Wright, San Francisco, Calif. *Secretary*—Paul S. Schmidt, General Electric Co., Oakland, Calif. *Board of Managers* — S. M. Blacksmith, C. D. Buchanan, F. M. Falge, R. W. Thunen.

Ohio Valley Section

Chairman—Beattie M. DeLong, Ft. Thomas, Ky. *Vice-Chairman* — Carl J. Ellis, F. D. Lawrence Electric Co., Cincinnati, Ohio. *Secretary*—E. J. McGinnis, Cincinnati Electrical Assoc., Cincinnati, Ohio. *Board of Managers*—R. W. Brown, H. K. Flint, V. G. McClusky, Ruth C. Schmoll.

Oregon Section

Chairman—Marvin S. Prestwood, Jr., Portland General Electric Co., Portland, Ore. *Vice-Chairman*—Donald W. Edmundson, Portland, Ore. *Secretary*—D. D. Moore, Benjamin Electric Mfg. Co., Portland, Ore. *Board of Managers*—F. M. Reis, G. H. Emory, R. W. Preston, D. W. Shirley.

Philadelphia Section

Chairman—Westerman McCouch, Philadelphia, Pa. *Vice-Chairman*—G. William Wagner, Philadelphia Electric Co., Philadelphia, Pa. *Secretary*—W. R. MacKinney, Westinghouse Electric Corp., Philadelphia, Pa. *Board of Managers*—J. B. Derr, R. R. Enghouser, D. D. Lees, W. H. Rademacher.

Pittsburgh Section

Chairman—Carl J. Long, Pittsburgh, Pa. *Vice-Chairman* — Hugh S. James, Duquesne Light Co., Pittsburgh, Pa. *Secretary*—James P. Boyden, Jr., Westinghouse Electric Corp., Pittsburgh, Pa. *Board of Managers*—W. A. Eisenhauer, J. A. Hodges, H. S. Orton, H. D. Siler.

Puget Sound Section

Chairman—Charles C. Fields, Love Electric Co., Tacoma, Wash. *Vice-Chairman*—G. D. King, Sylvania Electric Products Inc., Seattle, Wash. *Secretary-Treasurer*—Don A. Pearson, General Electric Co., Seattle, Wash. *Board of Managers*—R. E. Adam, J. C. Berg, E. D. Gilpin, K. E. Hollingsworth.

Rochester Section

Chairman—Royal M. Conheady, Rochester, N. Y. *Secretary*—Frederick B. Holcomb, Jr., General Electric Supply Corp., Rochester, N. Y.

(Continued on page 22A)

Architectural and Engineering Firms Light Their New Buildings with Wakefield STARS

For years Sanzenbacher, Morris and Taylor, Toledo architects and engineers, and the Toledo Engineering Company, specializing in glass plants, have worked together on many a project. When one decided to move from crowded downtown quarters to a new home on Toledo's outskirts, the other followed suit. Result: two new modern attractive one-story buildings side by side on the city's edge.

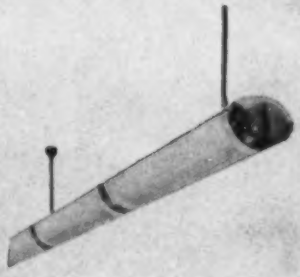
In designing both buildings, Sanzenbacher, Morris and Taylor made certain of one thing; they would rid themselves of the light glare which had plagued the drawing boards and offices of themselves and their fellow firm in their old quarters. Mr. Elmer Brigham, the architectural firm's electrical engineer, surveyed a variety of luminaires and purchased the Wakefield Star. His studies showed him that the Star put most of the light on the ceiling to be evenly distributed throughout the room; that there was little if any direct or reflected glare; that the resulting low brightness lighting made for almost effortless seeing. *The F. W. Wakefield Brass Company, Vermilion, Ohio. In Canada: Wakefield Lighting Limited, London, Ontario.*

Drafting Room, Sanzenbacher, Morris & Taylor

General Office, Toledo Engineering Company

LIGHTING INSTALLATION FOR SANZENBACHER, MORRIS & TAYLOR

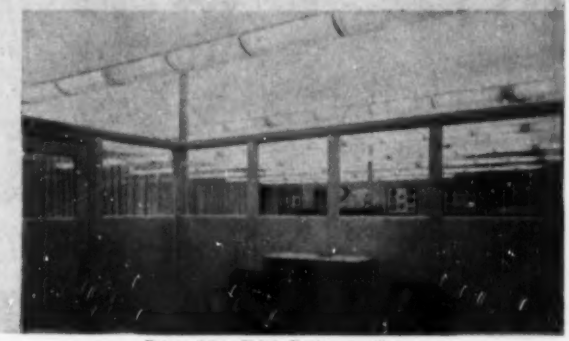
Drafting Room has continuous fenestration, 6 feet high by 76 feet long, on north side of building. Drafting Room and General Office have acoustical tile ceilings, light colored walls and light colored asphalt tile floors.
Continuous rows of 2-lamp Wakefield STARS, placed on 7'-9" centers and equipped with the 96T12 warm white lamp, were used.
There are thirty-three eight-foot luminaires installed; three rows (2 circuits per row) in the Drafting Room, and two rows in the General Office. Fifty to fifty-five footcandles are being maintained.



LIGHTING INSTALLATION FOR TOLEDO ENGINEERING CO.

General and Private Offices and Engineering Department have acoustical tile ceiling, light colored walls and drapes, light colored asphalt tile floor.
Continuous rows of 2-lamp Wakefield STARS, placed on 7'-0" centers, and equipped with the 96T12 warm white lamp, were used.
There are fifty-two eight-foot luminaires installed which are wired on eight circuits.
Sixty footcandles are being maintained in the General Office area.

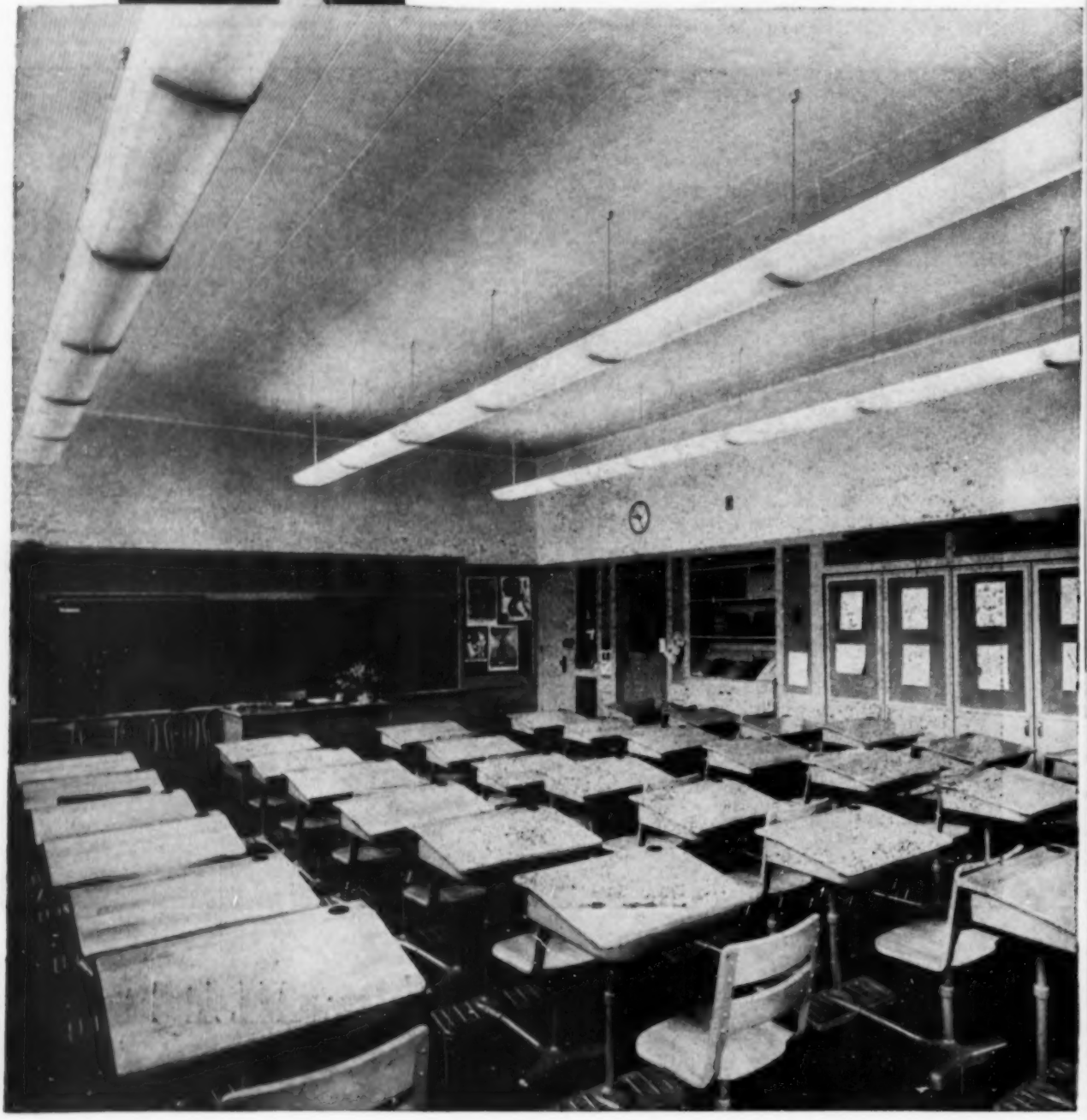
General Office, Sanzenbacher, Morris & Taylor



Private Office, Toledo Engineering Company

Wakefield Over-ALL Lighting

Supt. Frank D. Lawler, whose School Building Committee insisted on the most comfortable lighting, reports . . . . . .



. . "We wanted the best lighting available so we installed Westinghouse CD Luminaires"

"When we built the new Mary P. Hinsdale School, our School Building Committee insisted on the best and most comfortable lighting available. Westinghouse CD's have certainly lived up to those expectations," reports Superintendent Frank D. Lawler, Town of Winchester, Winsted, Conn.

The Westinghouse CD luminaire, with plastic shielding, provides a semi-indirect lighting system. Installed in continuous rows, as is shown in this classroom, the result is an almost glareless system of comfortable lighting. The entire ceiling becomes a part of the lighting system; all lamps are completely shielded.

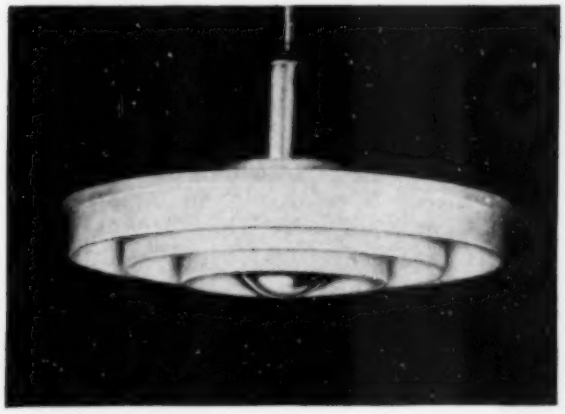
What's more, the Westinghouse CD makes an attractive addition to the classroom. Its design simplicity fits as a natural part of the background in modern interiors.

The superintendent further reports, "Our teachers and the school board are very pleased with the new lighting system. Their enthusiasm and that of our parents will undoubtedly influence both future construction and any remodeling of present classrooms."

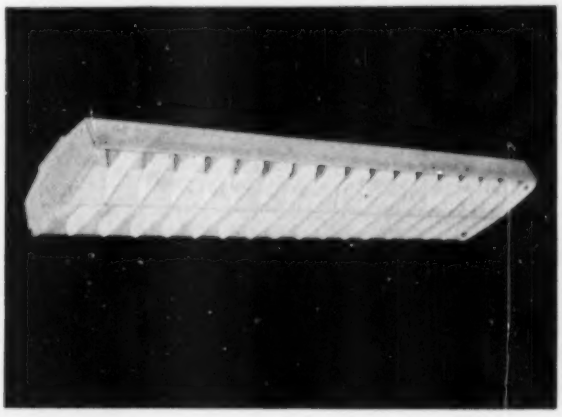
Warranty LIGHTING FIXTURES

For other installation methods, get B-4556, "The ABC Plan for School Lighting". Meantime—*look for this seal on your electrical contractor's guarantee. He installs them—we back him up.* Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa. J-04340-B

And to meet other requirements . . .



Low FIRST cost Concentric Ring incandescent luminaires meet quality lighting requirements on limited funds. Metal rings shield silvered bowl lamps, eliminating glare and shadows.



LC Luminaires—with *luminous corners*—bring new economies to fluorescent lighting not only in rugged efficiency but also in low maintenance and quality components.

LIGHT FOR FREEDOM · POWER FOR PROGRESS · DIAMOND JUBILEE

YOU CAN BE SURE... IF IT'S Westinghouse

(*Continued from page 18A*)

Board of Managers — Herbert Glick, N. T. Kridel, H. G. Linder, Earl Miller, F. H. Owen.

Rocky Mountain Section

Chairman—Charles O. Woodworth, Public Service Co. of Colorado, Denver, Colo. *Vice-Chairman*—Carl W. Strain, General Electric Co., Denver, Colo. *Secretary-Treasurer*—L. J. Carlon, Albert Sechrist Mfg. Co., Denver, Colo. *Board of Managers*—E. C. Dunn, A. F. Karpisek, Carl Schranz, Jr., A. D. Swanson.

St. Louis Section

Chairman — Brooks Chassaing, St. Louis, Mo. *Secretary-Treasurer* — Robert J. Welch, R. J. Welch Co., St. Louis, Mo. *Board of Managers*—G. F. Herold, E. H. Lauth, J. J. Rhoades, E. C. Ryan, L. M. Wallace, Jr

San Jacinto Section

Chairman—H. D. Webster, General Electric Co., Houston, Texas. *Vice-Chairman*—E. C. Ober, Southern Electrical Supply Co., Houston, Texas. *Secretary-Treasurer*—V. P. Flynn, Graybar Electric Co., Inc., Houston, Texas. *Board of Managers*—Fred Alsbury, H. G. Hrivnatz, C. A. Patterson, N. O. Reed.

Southern California Section

Chairman—F. Edwin Blair, Pasadena, Calif. *Vice-Chairman*—Roy H. Kreyser, Los Angeles Dept. of Water and Power, Los Angeles, Calif. *Secretary*—George A. Hochenauer, Benjamin Electric Mfg. Co., Los Angeles, Calif. *Board of Managers*—C. A. Gibbs, M. A. Potter, D. W. Prideaux, Del Reynolds.

Southwestern Section

Chairman—John G. Felton, Jr., Sylvania Electric Products, Inc., Dallas, Texas. *Vice-Chairman*—John E. Metzenthin, Crouse-Hinds Co., Dallas, Texas. *Secretary*—John B. Deck, Jr., Texas Power & Light Co., Dallas, Texas. *Board of Managers*—E. J. Fausonne, J. L. Healy, W. T. Kimery, F. J. Peabody.

Tennessee Valley Section

Chairman — William H. Ridley, Nashville Electric Service Co., Nashville, Tenn. *Secretary*—Charles H. Patterson, Donelson, Tenn. *Board of Managers*—Collin Finney, J. R. Harrell, J. W. McCullough, J. L. Simpson, Jr., W. B. Taylor.

Toronto Section

Chairman—M. K. Strang, Curtis Lighting of Canada, Ltd., Leaside, Ont. *Vice-Chairman*—K. R. Dunphy, Canadian General Electric Ltd., Toronto, Ont. *Secretary*—Bruce I. McCall, Mitchell Mfg. Co., Ltd., Toronto, Ont. *Board of Managers* — V. W. Diak, Thomas Dickson, H. J. McDonald, E. F. Wilson.

Twin City Section

Chairman—Donald R. Schwarz, Westinghouse Electric Corp., Minneapolis, Minn. *Vice-Chairman*—Cecil H. Branham, Minneapolis, Minn. *Secretary-Treasurer*—A. A. Aronson, Northern States Power Co., St. Paul, Minn. *Board of Managers*—G. W. Frederick, L. G. Hamilton, L. E. Johnson, J. A. Lang.

Western New York Section

Chairman — Bernard H. Plante, Snyder, N. Y. *Vice-Chairman*—Gordon Rowe, General Electric Supply Corp., Buffalo, N. Y. *Secretary-Treasurer*—Byron F. Lyth, Jr., Niagara Mohawk Power Corp., Buffalo, N. Y. *Board of Managers* — J. F. Buckley, F. Brendan Burke, W. B. Campbell, Neal Jacobus.

Three New I.E.S. Chapters Elect Interim Officers

At the June 10 meeting of the I.E.S. Council, three new Chapters were approved: Miami Valley, Palmetto and Arkansas. Working to prepare for Charter Meeting ceremonies in September, the Chapters have elected pro-tem officers.

The Miami Valley Chapter, with headquarters in Dayton, Ohio, has elected E. J. Rommal, Dayton Power & Light Co., as Chairman, and D. R. Hughes, Jr., Hughes Simonson Engineering Co., to the post of Secretary.

Greenville, S. C. is the center of activities for the Palmetto Chapter, which will serve all of South Carolina. Officers of this new Chapter are: Chairman, Roy E. Hallman, Westinghouse Electric Supply, and Secretary, Glen M. Rice, Huntington & Guerry Electric Co.

The Arkansas Chapter has chosen John S. Williams, Arkansas Power & Light Co., as Chairman, and as Secretary Paul F. Cratin. Both men are located in the Chapter's headquarters city of Little Rock.

ABOUT PEOPLE

John A. Wright has been elected President of Curtis Lighting, Inc., Chicago, Ill., succeeding **Darwin Curtis**, who remains a member of the Board of Directors of the company. Mr. Wright has been associated with Curtis Lighting for several years as the corporation's attorney.

Several promotions have been made in the engineering department of Westinghouse Lamp Division in Bloomfield, N. J. **John A. Linder** has been named staff assistant to **Dr. R. M. Zabel**, engineering manager; and **Mortimer Eber** is now technical advisor to Dr. Zabel. **George A. Freeman** has been appointed manager of lamp development, and the following engineering supervisors have been announced: **Thomas H. Heine**, fluorescent lamp section; **Frederick H. Rixton**, vapor lamp section; **Phillip F. Dietz**, miniature incandescent lamp section; and **Nicholas J. Rainone**, large incandescent lamp section.

The appointment of **Harold D. Talbot, Jr.**, as advertising manager for all products, except photographic lighting equipment, of the Lighting Division of Sylvania Electric Products, Inc., has been announced. Mr. Talbot will be located in the Salem, Mass., headquarters of the division.

Formation of two new General Electric Co. organizations, an Outdoor Lighting Dept. and a Rectifier Dept., has been announced, dividing the former Lighting and Rectifier Dept. **William J. Fleming**, formerly general manager of the joint department, has been named general manager of the new Rectifier Dept., while **L. Byron Cherry**, previously manager of Lighting and Rectifier Planning, has been appointed general manager of the Outdoor Lighting organization.

Carl E. Egeler, illuminating engineer in the Application Engineering Dept.of General Electric's Lamp Division, in Cleveland, retired June 1, after 40 years of service. Mr. Egeler, who is an active member of many I.E.S. committees, is continuing in the lighting field as consulting engineer, making his headquarters at his home at 3014 Berkshire Rd., Cleveland Heights, Ohio.

C. E. Egeler

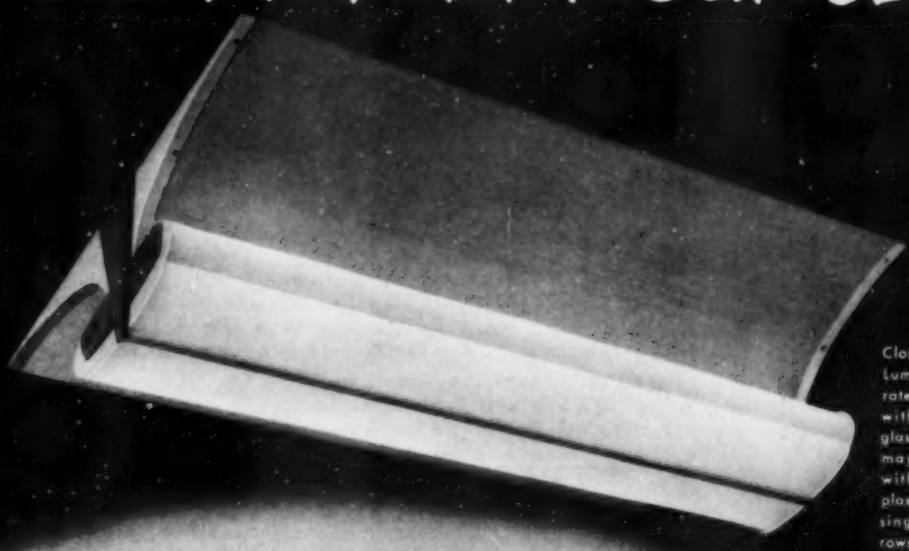
Seven of the nation's leading electrical engineers have been made fellows of the American Institute of Electrical Engineers for outstanding achievements in their profession. These are: **Ross D. Brown**, Monongahela Power Co.; **James DeKiep**, Electric Machinery Manufacturing Co.; **James E. Dingman**, Bell Telephone Laboratories; **Charles T. Hatcher**, Consolidated Edison Co.; **John V. L. Hogan**, Hogan Laboratories, Inc.; **Louis N. Grier**, Aluminum Co. of America; **George R. Town**, Iowa State College.

Roscoe S. Dick, manager of the Conneaut, Ohio, Base Works of General Electric's Lamp Division for the past 13 years, retired from active service on July 1. He is succeeded by **Alfred R. Erickson**, who has served as assistant manager of the plant for the past three months.

Pittsburgh Reflector Co. has appointed the firm of Wayne D. Close Co. as representative for fluorescent and incandescent lighting equipment in the Southern Texas territory. The firm, headed by **Wayne D. Close**, has its headquarters at 5904 Monsanta Drive, Houston. The company has also named the V. G.

(*Continued on page 25A*)

SYLVANIA ANNOUNCES—



Close-up of Sylvania Sono-Lume unit showing perforated metal wings backed with sound-deadening glass fiber batting. Fixtures may be also equipped with louvers instead of plastic shielding. Mounted singly or in continuous rows.

SONO-LUME.....

the Fixture† which Controls Sight and Sound

New fluorescent lighting fixture has built-in sound-conditioning system . . . easily installed!

Now Sylvania introduces SONO-LUME . . . a new concept of sight and sound control!

Basically, Sono-Lume is an attractive fluorescent fixture incorporating principles worked out by Sylvania engineers.

The perforated wings on each side of Sono-Lume fixtures are backed with glass fiber batting. This element has the excellent noise reduction coefficient of 0.85. Thus the fixture serves a double purpose: (1) It provides high levels of clear, soft, all-over illumination for comfortable seeing. (2) It holds unnecessary noise to low levels for comfortable hearing.

Saves modernization costs!

Sylvania Sono-Lume fixtures can be readily installed in any office, conference or consultation room. In instances where sound-proofing and better lighting are separate projects, this new combination fixture keeps costs well within modest budgets. A note on your letterhead will bring you detailed information. Simply address Dept. 4X-3507, at Sylvania.

QUALIFIED LIGHTING CONTRACTOR SYLVANIA

Look for this emblem—your guide to a Qualified Lighting Contractor.

*Sylvania Trade Mark
†Patent Pending

SYLVANIA

Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., St. Catherine Street, Montreal, P. Q.

LIGHTING · RADIO · ELECTRONICS · TELEVISION

(Advertisement)

New Product

Functional troffers installed to form unbroken line of light

LPI troffers give architects complete freedom in planning lighting arrangements

New troffers, *designed and built by Lighting Products, Inc.*, can be installed glass to glass to form a line of light unbroken by dividers. These troffers are adaptable to any known form of ceiling, and offer a wide selection of shielding media, including metal and plastic louvers, Holophane lenses (flat and curved), Albalite glass (flat and dished), and dished Plexiglas. All are interchangeable in the LPI troffer frame. This frame is quickly and easily slipped into place (no tools required) and is secured by a stable floating hinge, hidden from view. This eliminates the need for screws or other fastening devices which would mar the neat, clean appearance of the trim.

The unitized boxed construction of the LPI troffer body results in exceptional rigidity and assures perfect alignment in long runs. Engineered to prevent light leakage, the LPI troffer will accommodate from one to four lamps (preheat, rapid start, and slimline). It requires less than 8 inches in the ceiling and is suspended by LPI's patented Flexahanger which permits the contractor to install and adjust the troffer with complete accuracy. All lengths are standardized—24″, 48″, 72″, and 96″. They come in 12″ and 24″ widths.

For additional information and literature write Lighting Products, Inc., Dept. 6A, Highland Park, Illinois.

No screws or other devices mar the appearance of the troffer trim

(*Continued from page 22A*)

Christiansen Sales Co., **Vern Christiansen** heading the staff, as representative for the Iowa-Nebraska territory, from headquarters at 112 East Broadway, Council Bluffs, Iowa.

Clifton H. Emerson has been promoted to the position of Sales Manager of National Accounts, New England District, for Sylvania Lighting Division; and **Walter H. Howard** has been promoted to the position of District Sales Manager of the New England. Mr. Emerson's headquarters are at the company office at 60 Boston St., Salem, Mass.; while Mr. Howard is now located at the new district headquarters at 69 Loring Ave., in Salem.

The election of **A. C. Monteith**, vice-president in charge of engineering and research, Westinghouse Electric Corp., as President of the American Institute of Electrical Engineers was announced at the opening session of the five-day Summer and Pacific General Meeting of the Institute in Los Angeles. Mr. Monteith who succeeds **Elgin B. Robertson**, of Dallas, Texas, will take office August 1 for a one-year term.

John Losh, formerly with Smitheraft Lighting Division of A. L. Smith Iron Works, has accepted a position with Sunbeam Lighting, 777 East 14th Place, Los Angeles.

Morris Landers, Atlanta, Ga., representatives of Electro Silv-A-King Corp., of Chicago and Bridgeport, Conn., have announced the opening of an additional branch office at 604 13th, S. W., Birmingham, Aln. The office will be managed by **C. E. Parker**, who recently joined the company.

Norman D. Macdonald, Vice-President of the Electrical Testing Laboratories, Inc., retired from active service with the company on May 28. Mr. Macdonald, who first joined E.T.L. in 1904, continues as Director for the corporation.

Norman D. Macdonald

Dr. N. A. Halbertsma (extreme left) who recently retired from N. V. Philips' Gloelampen Fabreiken, Endhoven, Holland, has been elected to the grade of Member Emeritus of the I.E.S. Here he is shown in the cabin on board the chief engineer's motorboat, planning the lighting for the dike repairs in Zeeland last winter.

IT SEEMS TO ME

Prefabricated Coffer Ceilings

I read with interest, in the May issue of I. E., Mr. P. J. Grundfest's criticisms of my article, "Prefabricated Coffer Ceilings" (I. E., December 1953). I had thought "output" to be a simple, short, Anglo-Saxon word which engineers have used ever since I can remember, to say just what I intended to say. I am certain that in this country, most technically trained readers automatically related it to utilization efficiency which, of course, was plainly meant. Had I written what Mr. Grundfest has undertaken to dictate, *i.e.*, "high luminous efficiency with a relatively low brightness," I should indeed have taken liberties with lighting terminology.

"Luminous efficiency," as it is usually understood here, is not relevant to the subject matter of the article. It is, of course, the ratio of luminous flux to radiant flux — an elementary definition in illuminating engineering. I dislike being pedantic, but I must say that Mr. Grundfest might better have had his own letter cleared before sending it.

Again, Mr. Grundfest errs in implying that mathematical analysis might well have been employed in the design of the coffer curvature. The design problem is and was very simple, and I think the solution was clearly explained. It is well known that any matte (non-specular) surface (such as is clearly specified in the article) ruins the geometry of any reflected light pattern. This is true almost by definition. The primary reason, then, for the specified shape of the coffer is to provide a clear unbroken reflecting surface. It is also obvious that considerable and complicated interflection takes place within the coffer — but to what purpose would any analysis of it be put? It is easier and quite accurate to consider the ceiling as one luminaire and the figures show how much light is available from it for use.

The improved horizontal distribution, that is to say, the relative increase in vertical surface illumination from the coffer type of ceiling was, as many will remember, carefully tested and measured in 1948 and 1949 with the two types of ceilings adjacent. The article further clearly states that the coffers are now being made of laminated plastic (perhaps not yet in use in Australia) and painted with matte white enamel. This specification certainly does not, in the least, suggest translucence. Mr. Grundfest apparently has read things into the article which are not there.

A slight typographical error appearing in the equations showing the relationship of lamps to coffers was corrected in the reprints. I assume responsibility for this having read the galley proofs. These simple little algebraic expressions were put there as a matter of interest in order to relate the shape of any proposed array to its total light utilization, but more because they have saved much time in computing requirements for the many proposed spaces we are called upon to estimate.

Finally, if one is looking into the *inside* of a dome, is the viewer or the coffer inverted? If, as a matter of philosophy or semantics, the word is not properly used (and I am inclined to admit this point in Mr. Grundfest's favor), I stand corrected, but the fact neither warrants nor supports his implication that the article is misleading. LAURENCE HARRISON, *Consulting Engineer, Scarsdale, N. Y.*

Lighting and Power Graduates

There seems to be no doubt but that power and lighting majors in our engineering schools are being passed up by too large a percentage of students, in favor of electronics. The result inevitably must be a curtailment of instruction in these subjects and ultimately a serious lack of new man-power in the power and lighting branches of our profession and industry; also a corresponding lack of good opportunities enjoyed by graduates.

The question naturally arises as to why this condition exists and what should be done about it.

I believe it exists largely because of

(*Continued on page 26A*)

(*Continued from page* 25A)

pre-college conditioning of prospective engineering and physics students. Many of the present teachers in these subjects, both in college and in high school, have also been so conditioned.

The small boy plays with radio and television, without material concern as to the source of the energy. Later he may build sets. In high school he takes physics, in which all electricity comprises a very small part, under a teacher who probably means electronics when he even thinks of electricity. If you don't believe this, inquire. When the student enters college, perhaps with electrical engineering in mind, he finds familiar devices in the electronic laboratories with which he ultimately will play, compared with prosaic electric motors and visions of mathematics and design in power and lighting — he is sure the math in electronics must be more interesting. He is encouraged in his preference by many of the professors, who in turn have followed this procedure.

It seems to me the logical thing here is to introduce the high school physics teacher to the possibilities, personal and technical, in the older fields, not to the disadvantage of the new field of electronics but with a view to a more broad understanding. A number of I.E.S. members have agreed with me that one way to do this, so far as lighting is concerned, is by providing an "over-run" of I. E., available at a reduced rate of perhaps $5.00 or less to sustaining members for direct mailing to the science departments and libraries in various high schools. I. E. is particularly appropriate for this purpose because it contains both highly technical treatises and general application papers. It will also impress upon the science teachers the scope of illuminating engineering and the large number who evidently find lucrative employment in this field. Such a subscription might be called an educational library subscription and be limited to such library purposes. LEONARD V. JAMES, *Illuminating Engineering Consultant, 437 Sixth Ave., LaGrange, Ill.*

OBITUARY

Dr. Loyd A. Jones, internationally renowned scientist, recently retired as head of the physics division of the Eastman Kodak Research Laboratory, died unexpectedly on May 15. Dr. Jones was 73.

A world authority in the fields of photographic sensitometry, colorimetry and psychophysics of vision, Dr. Jones had received numerous national and international awards, contributed over one hundred technical articles to photographic journals and had served as president of the Optical Society of America and the Society of Motion Picture and Television Engineers.

A member of the Illuminating Engineering Society since 1914, Dr. Jones was elected to the grade of Fellow in 1932, in recognition of his many contributions in the fields of photometry, color and photography. He was also a Fellow of the American Physical Society, the Photographic Society of America, the Society of Motion Picture and Television Engineers, and of the Royal Photographic Society of Great Britain.

BOOKS AND PAMPHLETS

*Books whose reviews are marked * are available for inspection at Headquarters Office, Technical Dept.*

***Neuzeitliche Leuchten** by Alexander Koch, published 1953 by Verlagsanstalt Alexander Koch, GMBH, Stuttgart, Germany; 10+ 8¼ x 11¾ inch pages, 260 illustrations; price DM 29.50 (approx. $7).

This book presents photographs of contemporary lamps and luminaires designed both in Europe and the United States. All captions appear in German, English and French. The book is divided into six sections: I. Table Lamps, II. Desk Lamps, III. Floor Lamps, IV, Wall Lamps, V. Ceiling Lamps, VI. Space Lighting. The lamps are of novel design but unfortunately many do not meet I.E.S. recommended practice with regard to brightness limitations. However, they are indicative of current design trends which could incorporate good lighting principles.

Roster of leading lighting people in all countries, complete with addresses, has been compiled by the Commission Internationale de L'Eclairage, Central Bureau and is available from C. A. Atherton, Honorary Secretary of the C.I.E., Hopkinton, N. H.

14 Practical Ways to Advance with the Electrical Engineering Profession and the Electrical Industry outlines how membership in the American Institute of Electrical Engineers can help the student engineer, by keeping him abreast of latest developments in the profession through contacts with engineering leaders, courses provided by the Institute and other ways. It also shows how membership helps in job placement, provides discounts on Institute publications and makes students eligible for awards. The pamphlet is available from A.I.E.E., 26 West 46th St., New York 36, N. Y.

Better Lighting for Your Farm is a booklet available from Sylvania Electric Products Inc., covering the planning of farm lighting, how to light farm buildings and homes, outdoor lighting, and special lamps to help make the farm more productive. Under the heading, "special uses of light," the booklet discusses the use of light to increase egg production; grade eggs, fruits and vegetables faster; bring beneficial effects to poultry and livestock; and kill harmful bacteria. It also reports on experimental work in black light to trap insects and artificial light increase crop yields. The booklet is illustrated with photographs, drawings and charts. Farm owners, electrical contractors and others concerned with farm lighting are invited to send for a copy from Sylvania's Advertising Dept., 1100 Main St., Buffalo 7, N. Y., requesting booklet I673.

NEW MEMBERS

At the meeting of the I.E.S. Council held in New York, June 10, 1954, the following were elected to membership. Names marked ° are transfers from Associate Member grade.

ALABAMA CHAPTER

Associate Members:

Forman, M. W., Jr., Rust Engineering Co., Birmingham, Ala.
Parker, C. E., L. Morris Landers Co., Atlanta, Ga.

ARIZONA CHAPTER

Member:

Ware, J. A., Jr., John Allen Ware & Assoc., Phoenix, Ariz.

CAPITAL SECTION

Associate Member:

Mason, E. S., Sr., Verd-A-Ray Corp., Washington, D. C.

CAROLINAS SECTION

Member:

Smathers, R. F., Mill Power Supply Co., Greenville, S. C.

Associate Members:

Baker, W. D., Westinghouse Electric Corp., Greenville, S. C.
Black, H. G., Black Electrical Supply Co., Greenville, S. C.
Dearman, W. P., Bryant-Davis Electric Co., Inc., Greenville, S. C.
Turner, I. C., Noland Co. Inc., Spartanburg, S. C.

CENTRAL ILLINOIS CHAPTER

Member:

Jerome, B. A., Bemis Bro. Bag Co., Peoria, Ill.

CHICAGO SECTION

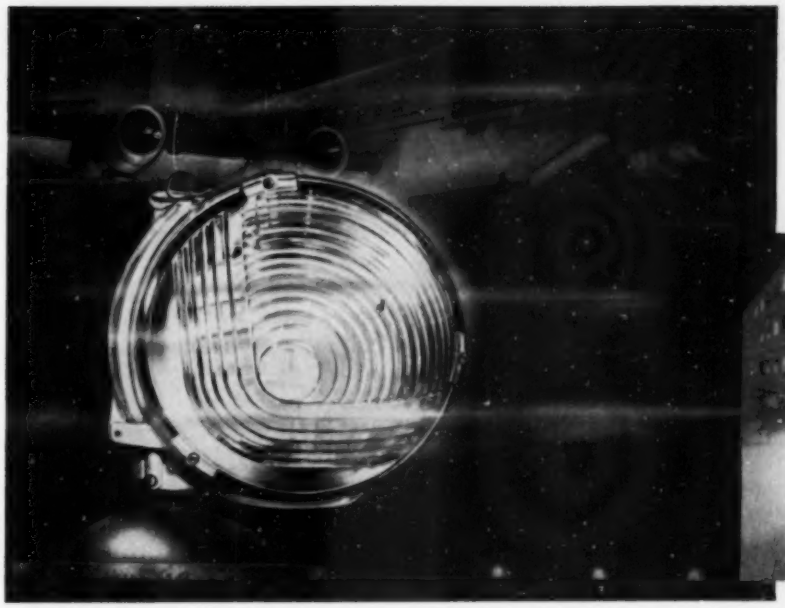
Member:

Peterson, C. A., Sola Electric Co., Chicago, Ill.

Associate Members:

Abramson, R. J., R. J. Abramson & Associates, Chicago, Ill.
Cahn, A. E., Simon Electrical Sales Co., Chicago, Ill.
Choate, D. L., Public Service Co., Harvey, Ill.
Dunbar, W. W., Anderson Electric Inc., Kankakee, Ill.
Franta, F. J., Trojan Metal Products Mfg. Co., Chicago, Ill.

(*Continued on page* 28A)



Through adverse weather, Corning runway marker lenses are clearly visible. The same specialized research and production facilities that produce airport runway markers are also devoted to Corning refractors for modern street lighting.

Lights that find the way never blind the way

Imagine what it's like to land a plane in pea soup fog.

An electronics system guides you to your proper approach and starts you down. As you follow the glide path, your eyes peer ahead to find the clear bright lights of the runway markers. Even in fog you find them. Their light penetrates adverse weather —*without* veiling glare or halo as you inch downward feeling with your wheels for the final touchdown.

You position yourself between them and safely set her down at speeds faster than you drive your car.

The origin of today's refractors

The glass lenses of the runway markers along the landing strip are made by Corning. Their superior light transmission is the result of research dating back to Corning's first search for improved glasses, better lens design and uniform colors for railroad signals.

In 1908, this research paid its first important dividend—the first dependable all-weather signaling glass for rail traffic.

With progress in transportation came progress in signal lenses for marine, aviation and street traffic. In commercial lighting, Corning lenses are used to control incandescent and fluorescent light for schools, stores, offices, hospitals and homes.

Corning street lighting products

The accuracy with which Corning street lighting refractors are made reflect *all* of the experience Corning has had in these other fields. They are optically designed to direct maximum light on the roadway over the greatest possible area. Light transmitting efficiency is unaffected by age. Quality control assures uniform lighting characteristics.

For these reasons, manufacturers who lead in the production of street lighting equipment use Corning refractors. It will pay you to investigate them for your lighting equipment, too.

Constant product and manufacturing research assure you of better designs and finished products, all with an eye to lower costs.

Precise optical design of lenses for control of light distribution and brightness is a science well known to Corning highway lighting engineers.

Automatic recording equipment is used to measure light distribution, brightness, transmission and diffusion characteristics for accurate product information.

Consulting engineering service is available through Corning sales and district engineers at all times to help solve application problems.

CORNING GLASS WORKS, CORNING, N. Y.

Corning means research in Glass

(Continued from page 26A)

Glass, H. A., Lighting Products Inc., Highland Park, Ill.
Goetzke, D. F., Verd-A-Ray Corp., Toledo, Ohio.
Green, D. M., Mitchell Mfg. Co., Chicago, Ill.
Kralovec, E. M., Jr., Kralovec, Mayer & Best, Chicago, Ill.
Levy, W. A., Joliet Electric Supply Co. Inc., Joliet, Ill.
Murer, S. A., Murer Electric Construction Co., Joliet, Ill.
Senesac, A. T., Electric Supply Corp., Chicago, Ill.
Shepherd, A. E., Merchants Electric Service, Chicago, Ill.
Simmons, Roy, Simmons Meat Merchandising Service, Chicago, Ill.
Thomas, C. R., Benjamin Electric Mfg. Co., Des Plaines, Ill.
Veit, Irving, Bright Electrical Supply Co., Chicago, Ill.
Wagner, C. L., Wagner Electric Company, Joliet, Ill.
Whitchurch, W. E., The Miller Company, Chicago, Ill.

Student Members:

Anderson, A. E., University of Illinois, Chicago, Ill.
Nichols, F. C., University of Illinois, Champaign, Ill.

CLEVELAND SECTION

Associate Members:

Johnson, W. H., Westinghouse Electric Corp., Cleveland, Ohio.
Unruh, E. H., Westinghouse Electric Corp., Cleveland, Ohio.

CONNECTICUT SECTION

Associate Members:

Blesso, J. H., Peerless Electric Co. Inc., E. Hartford, Conn.
Hepple, C. D., H. W. MacLeod Co., Boston, Mass.
Malinguaggio, Paul, Grace New Haven Hospital, New Haven, Conn.
Marrone, Ralph, Connecticut Light & Power Co., Essex, Conn.
Richardson, W. E., Hilton Hotels, New York, N. Y.

CORNHUSKER CHAPTER

Associate Member:

Mallette, F. D., Warren Electric Co., Sioux City, Ia.

EASTERN PENNSYLVANIA SECTION

Associate Member:

Snyder, W. T., L. P. Kooken Co., Carlisle, Pa.

FLORIDA CHAPTER

Member:

Damm, D. C., Lighting & Lamps, Inc., St. Petersburg, Fla.

FOREIGN NON-SECTION

Student Member:

Tucker, S. V., Gibbs & Hill, Inc., Tivoli Guest House, Balboa, Canal Zone.

GEORGIA SECTION

Member:

Anderson, J. E., Jr., 936 W. Peachtree St. N. W., Atlanta, Ga.

Associate Member:

Bush, Mrs. L. Ralph, 3953 Ivy Road, N. E., Atlanta, Ga.

IOWA SECTION

Member:

Holcombe, R. C., Interstate Power Co., Dubuque, Ia.

Associate Members:

Glass, L. D., Midwest Equipment Co., Des Moines, Ia.
Single, George, Crescent Electric Supply Co., Spencer, Ia.
Varvel, R. J., Electric Supply Co., Des Moines, Ia.

HEART OF AMERICA SECTION

Member:

*O'Connor, F. P., St. Joseph Light & Power Co., St. Joseph, Mo.

AT THE Capital Section's last meeting of the year on June 2, are Miss Dorothy Nickerson, Chairman-elect, and current Chairman Claude Engle. Some 57 members and wives and guests enjoyed the Ladies' Night Party, which included golf in the afternoon and a Nickelodeon Theatre Show and quiz show in the evening. The meeting was held at the Argyle Country Club in nearby Maryland.

MARITIME CHAPTER

Associate Member:

Doty, F. L., Canadian General Electric Co., Ltd., St. John, N. B.

MARYLAND SECTION

Associate Member:

Ehrlich, S. E., Excello Public Service Corp., Baltimore, Md.

MICHIGAN SECTION

Associate Members:

Bailey, T. B., General Electric Co., Detroit, Mich.
McCormick, N. E., Consumers Power Co., Adrian, Mich.
Segall, A. B., Bernard F. Segall, Detroit, Mich.
Segall, B. F., 16244 Wyoming, Detroit, Mich.
Spencer, H. L., Consumers Power Co., Flint, Mich.

MID-SOUTH CHAPTER

Associate Member:

Rowe, H. R., Line Material Co., Pine Bluff, Ark.

Student Member:

Vermeer, R. J., Southern College of Opotmetry, Memphis, Tenn.

MILWAUKEE SECTION

Members:

*Cramer, Fred, Northern Light Co., Milwaukee, Wis.
*Hausler, J. H., General Electric Supply Co., Milwaukee, Wis.

Associate Member:

Skrip, J. A., Northern Light Co., Milwaukee, Wis.

Student Member:

Stumpf, H. W., Wisconsin Telephone Co., Milwaukee, Wis.

MONTREAL SECTION

Associate Member:

Oldham, Victor, Canadian General Electric Co., Montreal, Que.

NEW ENGLAND SECTION

Associate Members:

Benoit, A. J., State of New Hampshire, Dept. of Public Works-Highways, Concord, N. H.
Carr, J. E., General Electric Co., Boston, Mass.

NEW MEXICO CHAPTER

Associate Member:

Hamilton, Mrs. Vivian B., The Hamilton Shop, Clouderoft, N. M.

NEW YORK SECTION

Members:

*McCandless, Stanley, Century Lighting, Inc., New York, N. Y.
Sullivan, C. W., Jr., The Union Metal Mfg. Co., New York, N. Y.
Taylor, E. L., International General Electric Co., New York, N. Y.

Associate Members:

Garelick, William, Belmar Lighting Co., Englewood, N. J.
Mayo, R. W., Today's Business (B. J. Martin Co.), New York, N. Y.

NORTHERN CALIFORNIA SECTION

Member:

*Cohn, Sol, California Electric Supply Co., San Francisco, Calif.

Associate Member:

Ames, E. J., San Francisco Lighting & Supply Co., San Francisco, Calif.

OHIO VALLEY SECTION

Associate Members:

Bootes, D. E., Dayton Power & Light Co., Dayton, Ohio.
Grier, G. A., Dayton Power & Light Co., Dayton, Ohio.
Maier, G. H., Dayton Power & Light Co., Dayton, Ohio.
McKeand, J. F., Walker Norwick & Associates, Dayton, Ohio.
Morrison, A. R., Dayton Power & Light Co., Dayton, Ohio.

OREGON SECTION

Member:

*Krieg, A. F., Portland General Electric Co., Portland, Ore.

Associate Members:

Paisley, G. E., Eoff Electric Co., Eugene, Ore.
Shelley, J. H., W. R. Grasle Co., Portland, Ore.
Taylor, R. R., Ace Electric Co., Portland, Ore.

PHILADELPHIA SECTION

Member:

Kallas, Endel, Jack Steel Co., Philadelphia, Pa.

Associate Member:

Zuckerkandel, Samuel, Paul F. Kyack, Philadelphia, Pa.

PITTSBURGH SECTION

Member:

Frame, R. G., Frame Electri Co., Pittsburgh, Pa.

Associate Members:

Britton, J. X., Globe Lighting Products, Inc., Brooklyn, N. Y.
Nuss, N. E., Luminous Ceilings, Inc., Clairton, Pa.

PUGET SOUND SECTION

Associate Members:

Fairbairn, R. W., Donald W. Close Co., Seattle, Wash.
White, R. E., Westinghouse Electric Supply Co., Tacoma, Wash.

ROCHESTER SECTION

Associate Member:

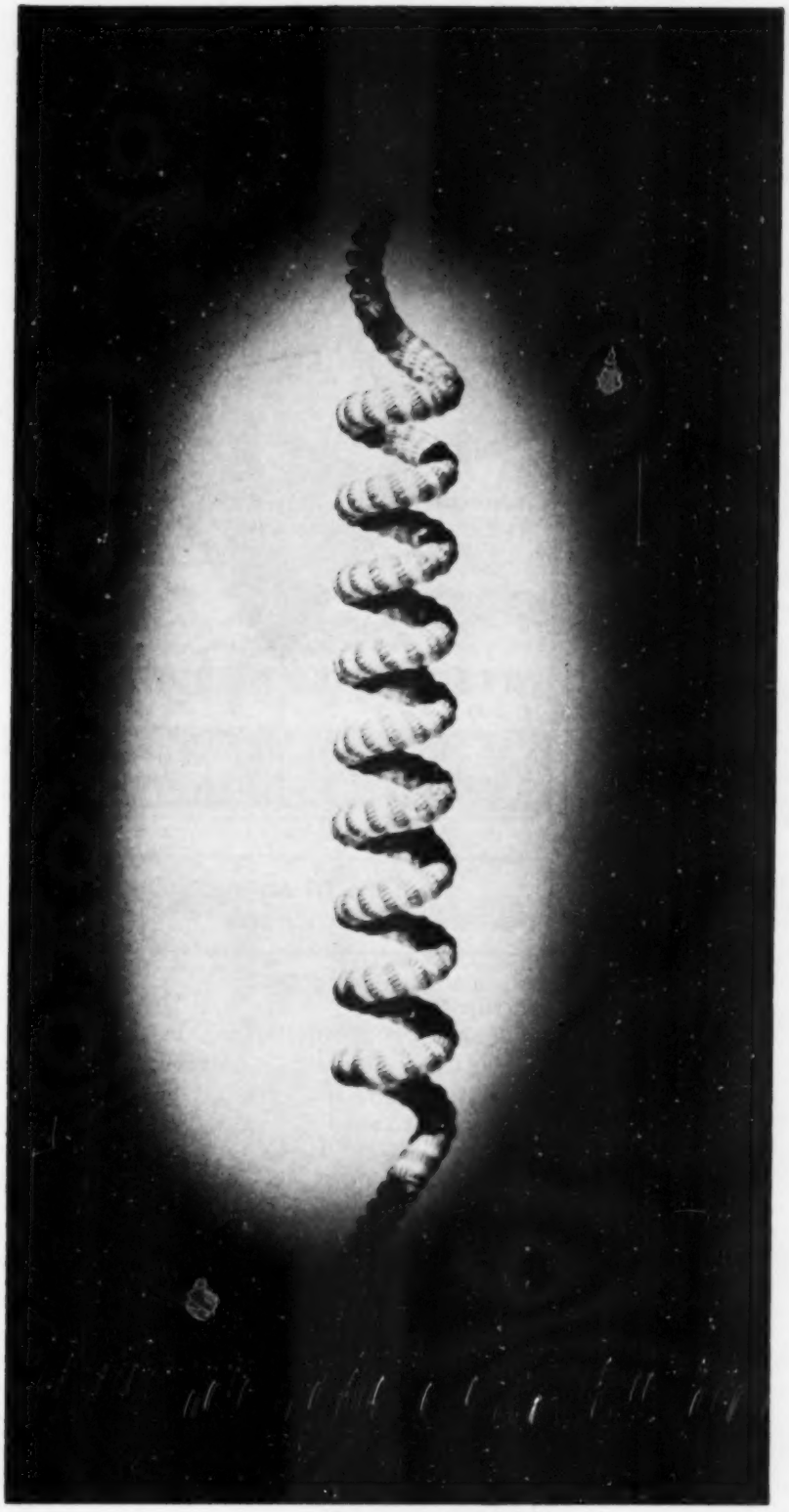
Miller, G. F., Robson & Woese Inc., Rochester, N. Y.

ROCKY MOUNTAIN SECTION

Associate Member:

Watson, R. E., Fluorescent Maintenance Co., Denver, Colo.

(Continued on page 30A)



New twist on old idea makes G-E fluorescent lamps last longer

ONE of the most important materials in a fluorescent lamp is the little bit of chemical at each end of the tube. The current flows through it, electrons flow out, and the lamp starts to glow.

The old idea was to hold the chemical on a double-twisted wire coil. General Electric's new idea was to go that one better: give the wire a *triple* twist. This not only holds more chemical, it also holds it longer.

The result of course is longer lamp life and more light for your money.

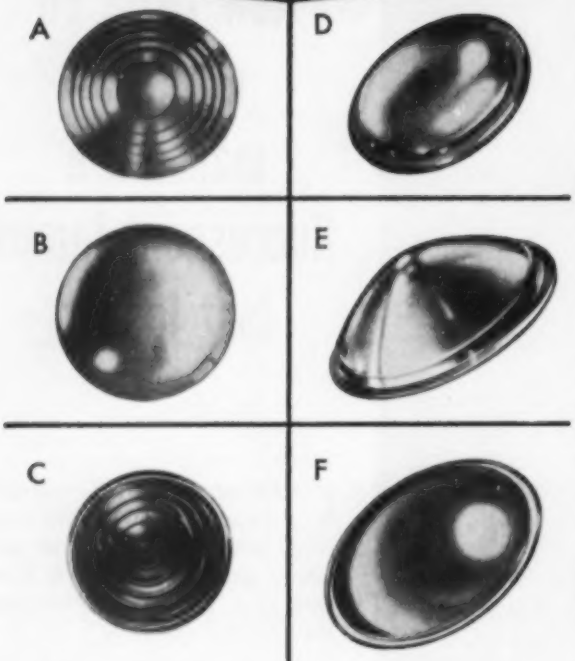
General Electric's triple coil is used in G-E slimline and other G-E instant-start lamps. Just one more example of why...

You can expect the best value from General Electric fluorescent lamps

Progress Is Our Most Important Product

GENERAL ELECTRIC

These Lancaster Stock Items Can Help Solve Your Lighting Glassware Problems



A. Pressed Flat Fresnel Lenses—heat-resisting and soda-lime glass — 3" to 8" diameters.

B. Ground and Polished Plano-Convex Condenser Lenses — soda-lime plate and heat-resisting glass — up to 10" diameters.

C. Semaphore Lenses — crystal and colored glass — various diameters.

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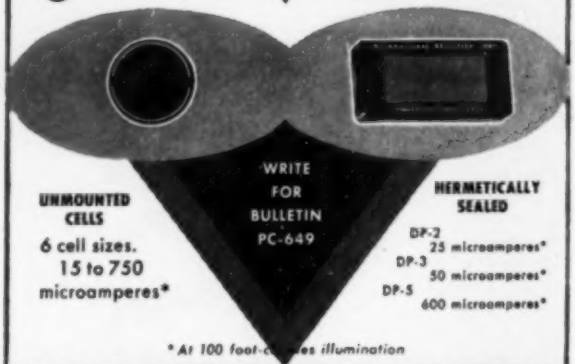

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(Continued on page 32A)

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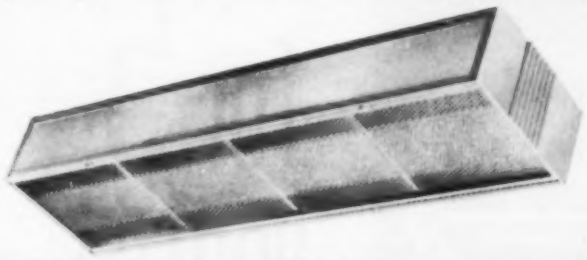

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(Continued from page 31A)

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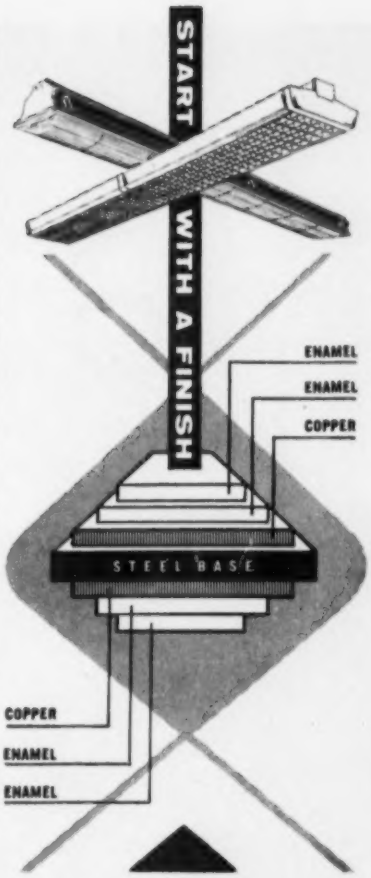

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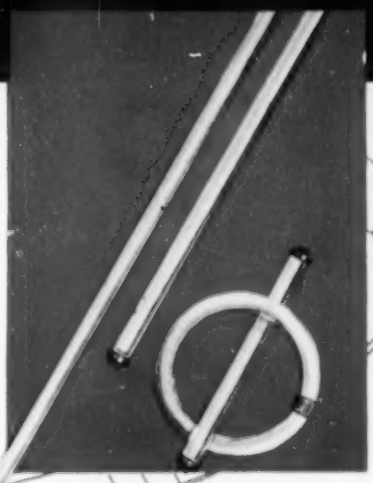

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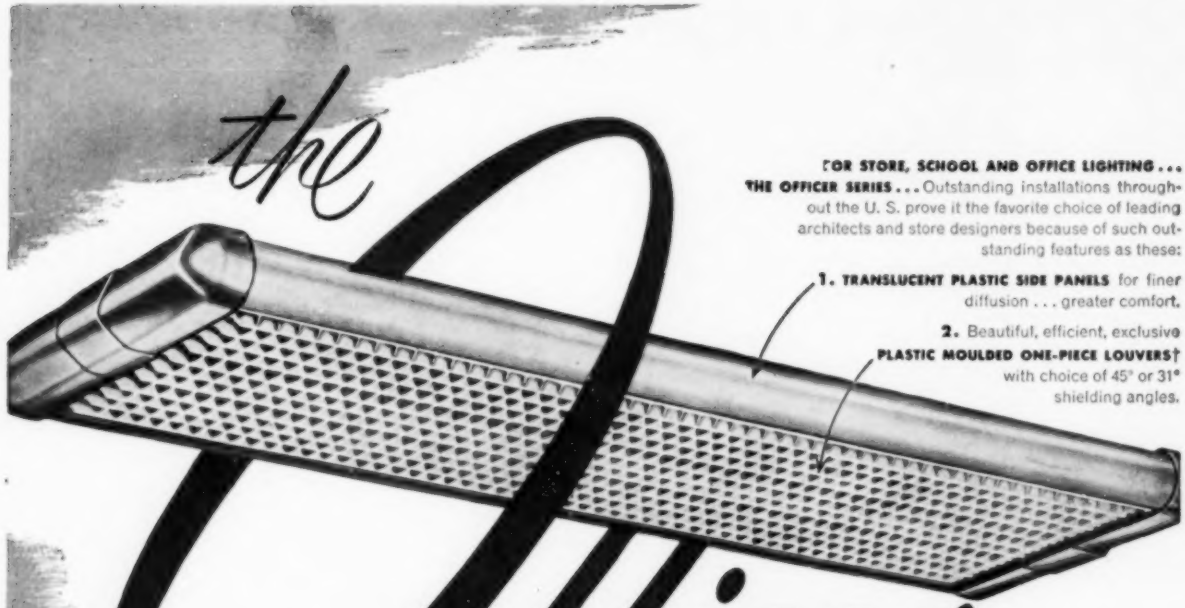

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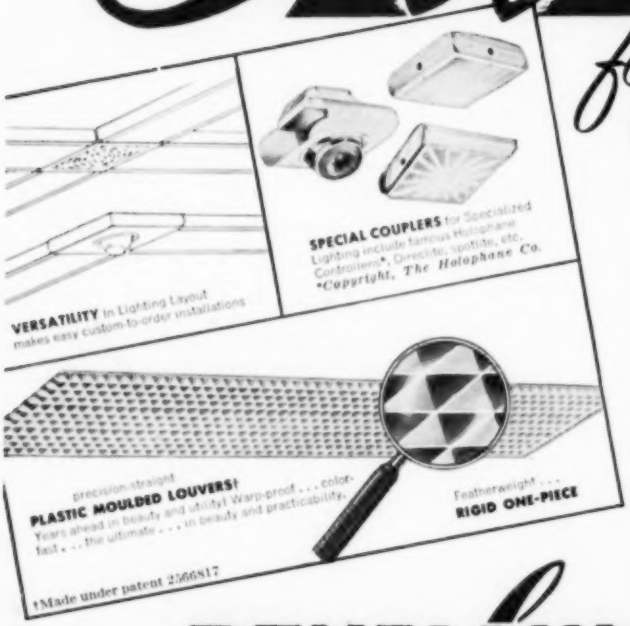
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